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Science Reporter

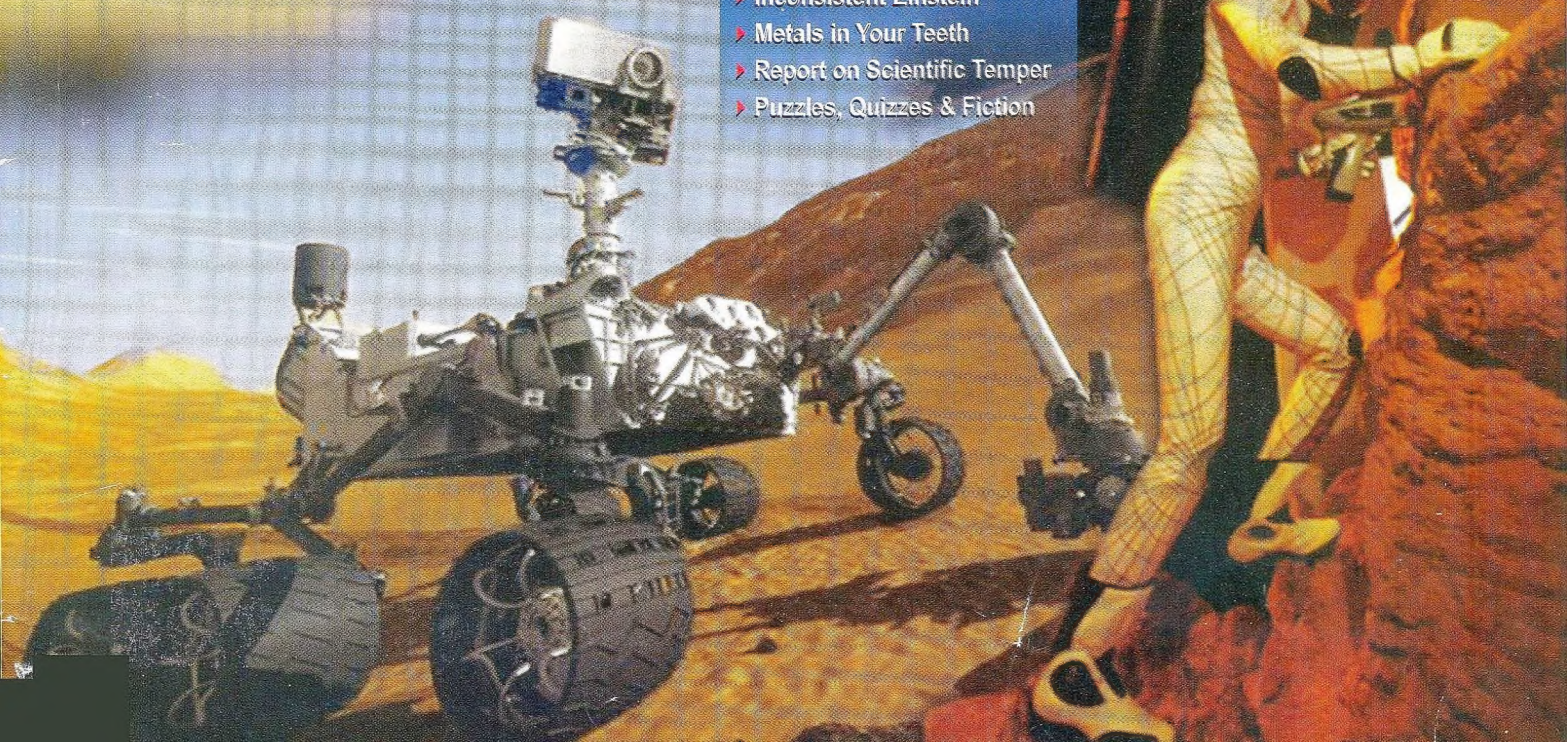
A CSIR PUBLICATION

SPACE 2012

Exploring New Vistas

Also in the issue

- Inconsistent Einstein
- Metals in Your Teeth
- Report on Scientific Temper
- Puzzles, Quizzes & Fiction



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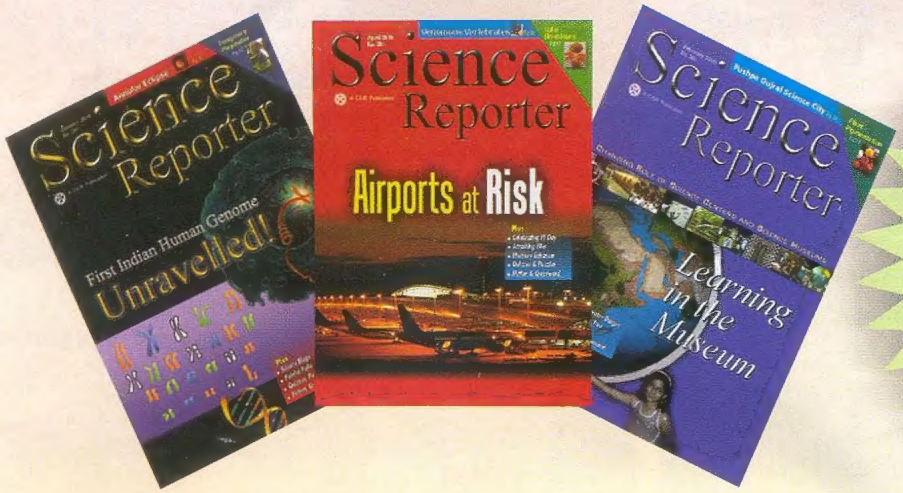

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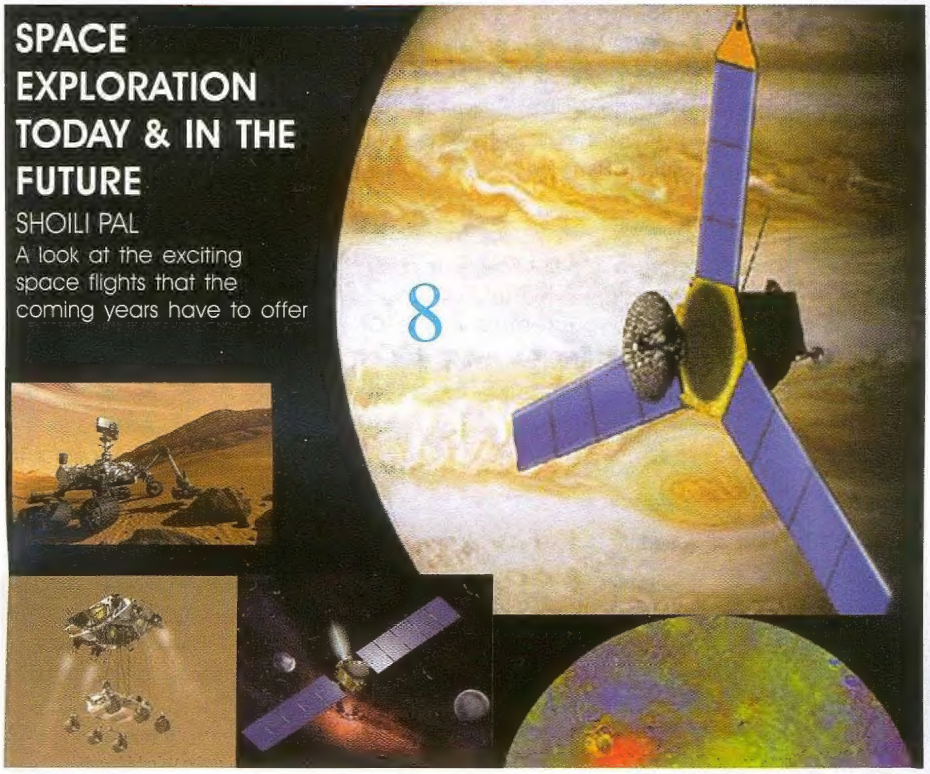

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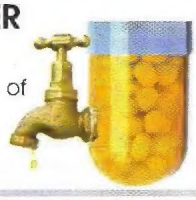

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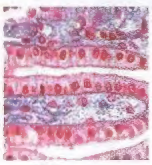

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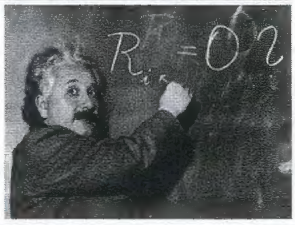

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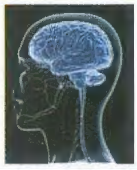

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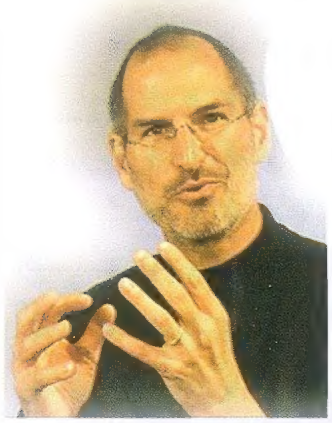
Science Reporter

Inspiration for Youth

This refers to the article **Will Steve Rest in Peace?** by S.G. Seetharam (SR, November 2011). The death of Apple co-founder Steve Jobs marks the end of an era. The greatness of Steve Jobs lies in his indomitable courage. After having faced many difficulties



in life and being a college dropout, there was many a time in his life when he did not know what next to do. Steve Jobs failed to pursue an academic career, but it did not hamper his growth in life.

The greatness of this icon lies in his indomitable courage and his being a great visionary with entrepreneurial zeal. His hard work was responsible for changing the daily habits of millions by reinventing computing and mobile phones. No doubt, his death resulted in an outpouring of tributes. He is also an inspiration for many in India, especially the youth.

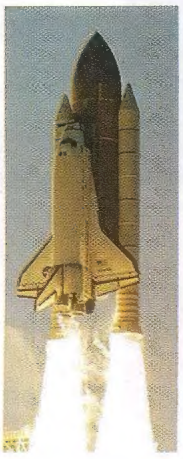
Despite the fact that he was thrown out of Apple in 1985 he did not give up. He returned to the company in 1997 and after a few years began to roll out a host of products like the iPod, the iPhone and the iPad.

Indian youths, who graduate from premier institutions, should emulate the great man and establish their own companies. They should not strive to become job seekers but job providers.

Dr. S. K. Aggarwal
Dean Academic Affairs
Amritsar College of Engineering and Technology

Historic Space Shuttle

The article **Legacy of the Space Shuttle** published in the September 2011 issue was really amazing. *Science Reporter* always keeps us updated with the latest scientific events, major or minor. NASA's 30-year shuttle program that recently ended was a great historic moment in the field of space research and technology. It is because of these missions that we have the Hubble Telescope and several other developments in space.



I have been reading *Science Reporter* since the last five years regularly when I was in class 7th and have been writing in the Point Counterpoint column. This has helped me in not only increasing my knowledge but also in excelling in academics as well as Olympiads too. A hearty thanks to *Science Reporter*.

Shubham Kumar Singh
Patna, Bihar

Search Comes to an End

I had been searching for some information on the topic of Dark Matter and my search finally ended P.K. Mukherjee's article, **The Enigma of Dark Matter**, in the October 2011 issue. The article was fabulous and very informative. It is said that the person who ultimately cracks the mystery of Dark Matter will get the Nobel Prize for that particular year in Physics.

Zubair Bangroo
J&K

Unique Mammals

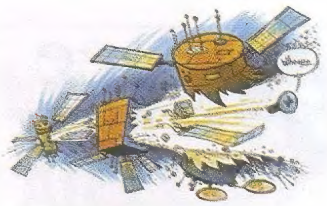
I liked your feature article **Of Pachydermic Bondage!** (September 2011) that

contained some unrevealed secrets of elephants. Elephants are one of the biggest mammals found on earth but their intelligence and feelings for their family members makes them unique.

Ashutosh Kumar Mishra
Lucknow
akmishraa4@gmail.com

Space Debris

From time to time various suggestions have been mooted for removing waste material, responsible for causing congestion and collision risk, littering outer space. Some pertinent suggestions have been outlined in **Mounting Threat of Space Debris** by Radhakrishna Rao (November 2011). Besides those already enumerated in the article there are proposals to ferry the space garbage of non-functional satellites and spent stages of rockets, etc. to a "junk orbit". It was also suggested to retrieve material,



which had outlived its utility, with the help of mechanical arms and hoist it in the bays of space shuttles.

However, in July this year the last space shuttle *Atlantis* successfully performed its flight, concluding the shuttle programme. So the concept which could have far reaching consequences could not be implemented. It appears NASA has not completely mastered this aspect of space flight or they consider it to be too expensive and not worth the trouble. There are reasons to believe that the agency has not been provided budgetary allocation for the purpose. Mishaps involving Cosmos-954, Skylab, Cosmos-2251, and recently UARS are a pointer to the lackadaisical approach. No doubt NASA is fully aware of the potential threat from tens of millions of miniscule specks larger than a centimetre hovering in low-earth orbit.

Dr. S.K. Gurtu
Mansarovar, Jaipur

Butterflies: Declining in Numbers

Samiya Fatima's article on butterflies published in the November 2011 issue of SR brought us face to face with the current condition of butterflies all over the world. From the earthworm to the blue whale, each one has its own role to play in the environment. So too with butterflies. Extensive deforestation and other factors are responsible for bringing these creatures on the verge of extinction. I thank SR for printing such a topic of concern and spreading awareness among us.

Nandini Acharya
Durgapur, West Bengal

निस्केयर
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Science Reporter

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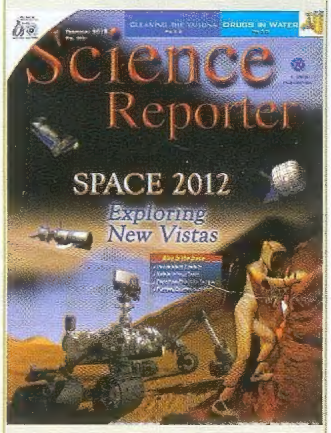

COVER DESIGN
NEERU SHARMA

MAKING THE SCIENCE 'MELA' RELEVANT

The 99th Annual Session of the Indian Science Congress concluded recently at the KIIT University in Bhubaneswar. One of the biggest scientific events in the country, the Science Congress is held during 3-7 January at a different location every year. The annual Science Congress that started in 1914 in Kolkata to "stimulate scientific research in the country through a gathering of research workers" attracts thousands of scientists, researchers, policy planners, teachers and students, and often politicians too.

The last few sessions of the Science Congress have been hosted by private universities such as the Annamalai University, SRM University, Nirma University, KIIT University and so on. Which means that, thanks to their financial muscle, sponsorships, and organizational capabilities, the facilities have been quite up to the mark. But, does that mean central and state universities would never be able to host the Indian Science Congress? This is something the authorities need to look into.

Science and scientists have to be the focus of this annual scientific event. Sadly, perhaps due to certain considerations, there is a feeling that politicians and bureaucrats are fussed over while scientists are given short shrift. This has led over the years to some of the top and most brilliant scientists of the country shunning the event.

The Science Congress is a wonderful platform for Indian scientists to showcase their work. The technical and scientific sessions, therefore, need to be especially strengthened. These sessions need to attract young and brilliant scientists to present papers rather than allowing presentations of papers that are two or three years old or that have been rejected at other fora. Not surprisingly, therefore, not much of significance has been coming out of the Science Congress in recent years.

Several plenary sessions are most enlightening. But there are certain sessions that seem to lack focus. A case in point is the Science Communicator's Meet where rather than discussing the challenges and efforts made in the field of science communication, totally irrelevant papers are presented. This has to change if the Science Congress has to become relevant ever.

Of course, there have been a few good things also happening over the years. Lectures by Nobel Laureates and interactions with the country's eminent scientists are especially motivating for the young. The Children's Science Congress is another good initiative that helps groom young scientists. A good beginning has also been made with the initiation of the science films festival, held for the first time at the 98th Indian Science Congress. The 99th Science Congress saw increasing involvement of film makers and enthusiastic participation from the public and students. Science film making is still at a nascent stage in the country and is sure to receive a boost riding on the success of such initiatives.

A 'mela' it is, a celebration of science, but let us make this annual event more scientifically relevant.

Hasan Jawaid Khan

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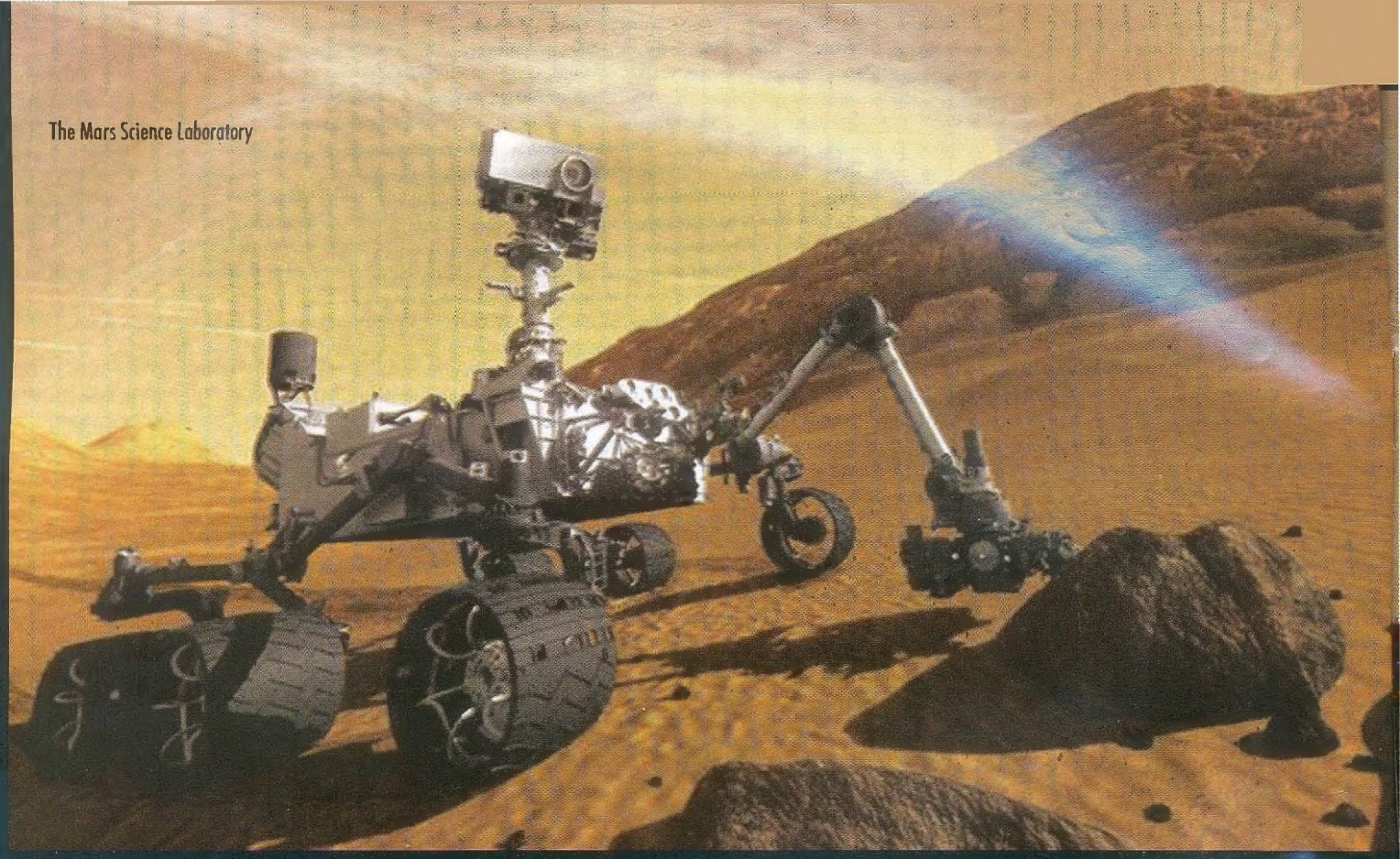


The Mars Science Laboratory

Space 2012:

The year 2012 seems to be an exciting year for space travel with various space agencies around the world lining up innovative and penetrating missions to space and beyond.

SHOILI PAL

As you are reading this right now, sitting on earth, a space rover called *Curiosity*, onboard a rocket called the *Atlas V*, is speeding away towards Mars. *Curiosity*, also called the Mars Science Laboratory or MSL in short, is going to explore if Mars is habitable.

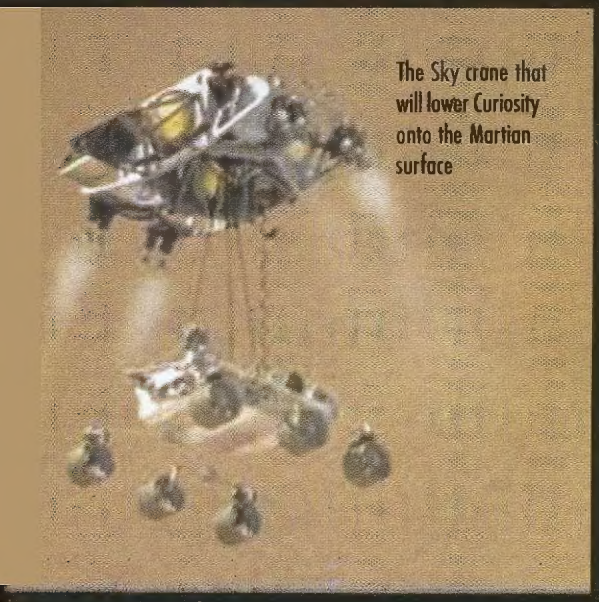
Meanwhile, another spacecraft is winding its way to Jupiter and will enter its orbit in another five years. The *Dawn* spacecraft that reached Vesta in July 2011 is due to start off on its journey towards Ceres in June 2012.

The year 2012 looks to be an exciting year for space exploration. Let's take a look at the various missions which may be headed towards new discoveries, starting off with our neighbour planet Mars.

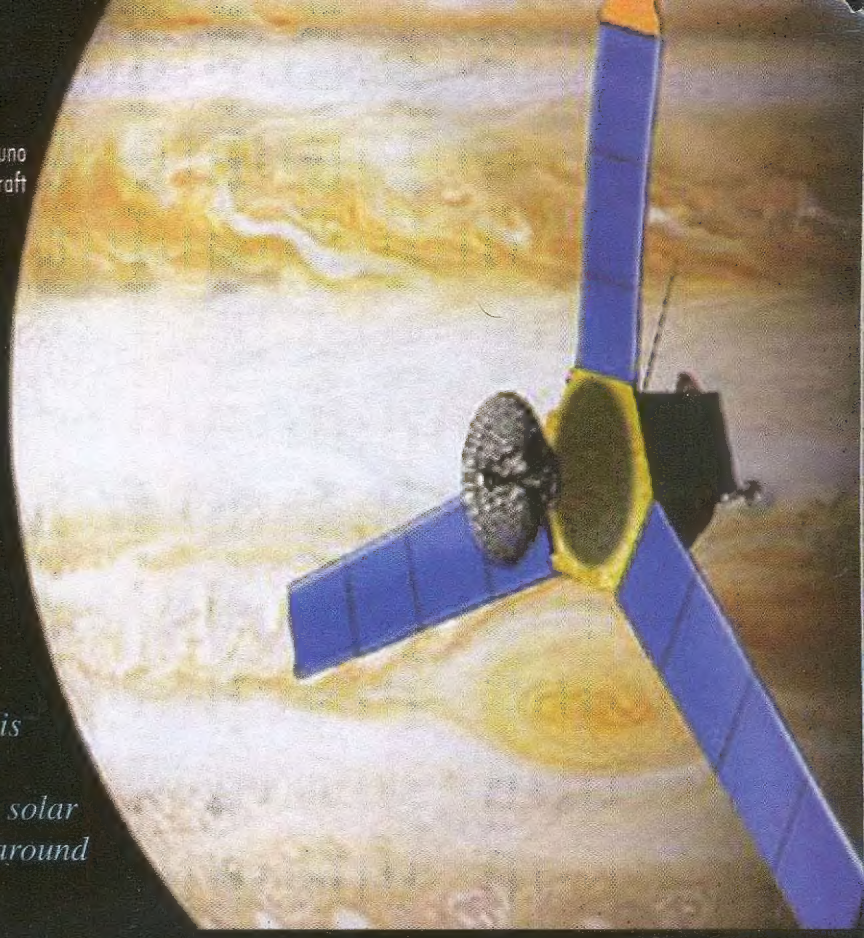
Humans on Mars?

The Mars Science Laboratory, christened *Curiosity*, was launched on the 26th of November 2011 from Cape Canaveral in Florida. It will land in the Gale crater on Mars in August 2012 if everything goes according to plan.

The rover weighs almost two thousand tons, more than the last three Mars rovers put together, and so landing it on Mars will be a challenge. Two-thirds of previous missions sent to Mars have either crashed or lost contact with Earth. Methods like airbags to cushion a freefall will not work, given the weight of *Curiosity*. To solve this problem NASA has designed an ingenious rocket-powered 'sky-crane' that will hover above the surface and lower the rover gently down to the Martian surface.



The Sky crane that will lower Curiosity onto the Martian surface



The Juno spacecraft

ISRO, the Indian Space Research Organisation, is planning to launch a spacecraft named 'Aditya' sometime this year or the next, a period of high solar activity. It will orbit the earth at an altitude of around 600 kilometres.

Space Exploration, Today and in the Future

Jupiter's colourful belts

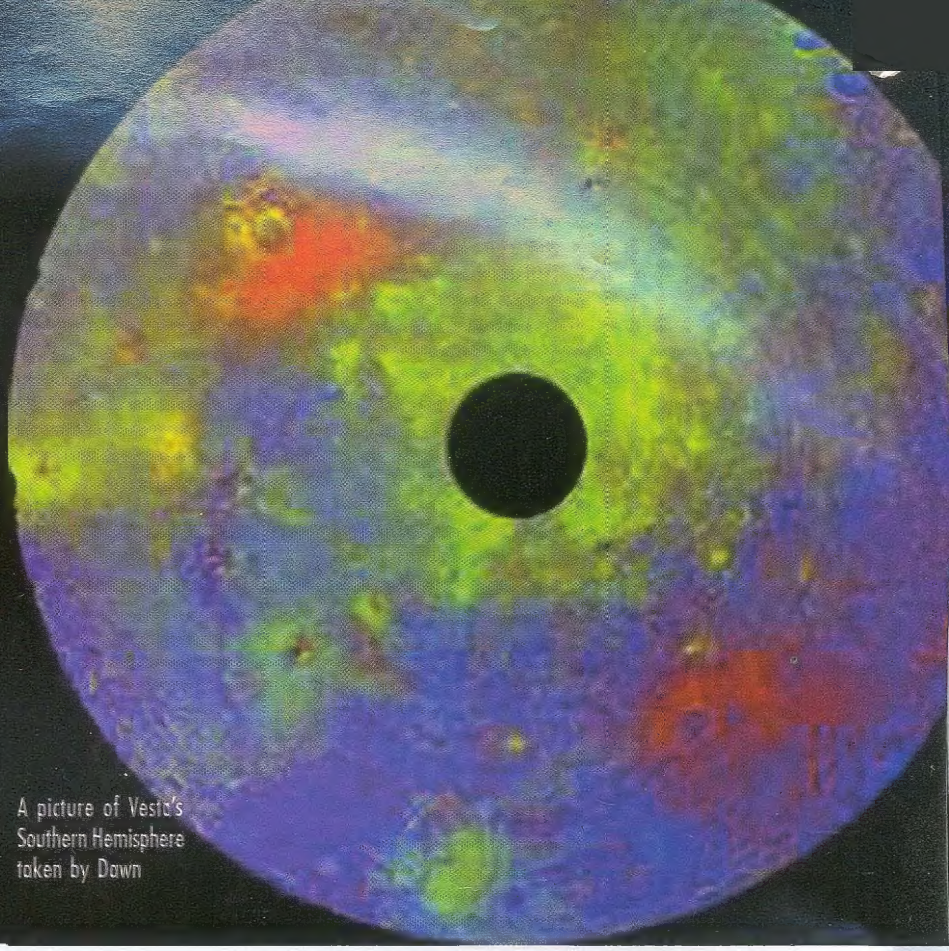
So why is *Curiosity* so heavy? The reason is, it is carrying a large collection of instruments to Mars. These instruments are among the most sophisticated technology ever sent to space. In fact, the instruments are so numerous and so varied in function that NASA has likened the rover to a living creature. The 'body' of the creature is a warm box that protects the circuits and controls the temperature inside. The 'brain' of the box is the computer onboard. The rover has a robotic arm that will work much like a human geologist's arm would, scraping and collecting samples.

The rover has ten cameras that can be likened to its eyes. Some of these cameras are simply for navigation. Some are for scientific purposes. The MastCam will capture colour pictures and video of the Martian terrain. There are some spectrometers on board. These will try to identify the chemical substances on Mars like minerals, water and carbon-based compounds. An instrument called the ChemCam will use a laser beam to vaporise thin layers of a target, take pictures of the illuminated areas and identify the excited atoms with a spectrometer.

There are two radiation detectors onboard the *Cusiosity* called RAD and DAN. 'RAD' stands for Radiation Assessment Detector and will measure all the high intensity radiation near the surface. 'DAN' stands for Dynamic Albedo of Neutrons and will measure neutrons escaping the surface, thus helping the search for water on Mars.

The Spanish government is also contributing a weather monitoring to the rover's scientific payload. It will measure atmospheric pressure, winds, temperature and humidity.

The Dawn spacecraft



A picture of Vesta's Southern Hemisphere taken by Dawn

Humans are also aiming to visit asteroids. US President Obama has set sight on achieving this aim by 2025. Asteroids being much smaller than the planets, their gravity is much less and astronauts could float away into space.

The whole thing is powered by radioactive plutonium.

So what is the unified aim of all these instruments? They will try to collect data to help us ascertain if Mars can or ever could support life. But how will we reach the conclusions?

The Gale crater was chosen for the *Curiosity* landing for a particular reason. In fact, it was chosen after a series of workshops where many sites were considered. The rover will land near the foot of a mountain. It will explore a mound of materials that are stratified, i.e. formed in layers, and may contain evidence of major climatic changes. On the basis of data collected about the minerals found, scientists can look for biosignatures. A biosignature is a phenomenon produced by life. For example, the presence of a photosynthetic pigment would be a sign that life may have existed at a place.

The year 2012 looks to be an exciting year for space exploration. There are various missions which may be headed towards new discoveries, starting off with our neighbour planet Mars.

Apart from Mars, humans have identified Jupiter's moon Europa as being the most likely place in the solar system where life might be found. Europa has oceans under its surface.

In short, *Curiosity* will revolutionise our understanding of Mars. The data about the atmosphere and weather collected will take us closer to being able to send a manned mission to Mars. The European Space Agency plans to perform this by the year 2030.

Exploring the Outer Planets

Another exciting mission is presently on its way to Jupiter. The mission is named *Juno* because in Greek mythology it was Jupiter's wife, the goddess Juno, who could look through the clouds surrounding him, to his true mischievous self.

Launched in August 2011, the spacecraft took just a day to cross the earth's moon but it will take another five years to reach its destination. The mission is a part of NASA's New Frontiers program which aims to send spacecraft to conduct highly focused scientific investigations to help us better understand the solar system.

Jupiter, the largest planet, is a gas giant. It is made of mostly helium and hydrogen. It was probably formed in the early stages of the solar system, out of the materials left over from the formation of our sun. Thus, studying Jupiter may improve our knowledge of the origins of the solar system and also enhance our understanding of other planetary systems being discovered around other stars.

Juno will orbit Jupiter thirty-three times in one year, each orbit lasting for eleven days. The orbit will be around the poles and the spacecraft will be spinning to simplify the scientific operations.

Juno will observe Jupiter's gravitational and magnetic fields. It will also measure the water and ammonia in Jupiter's atmosphere to better understand the belts of colourful clouds that cover Jupiter.

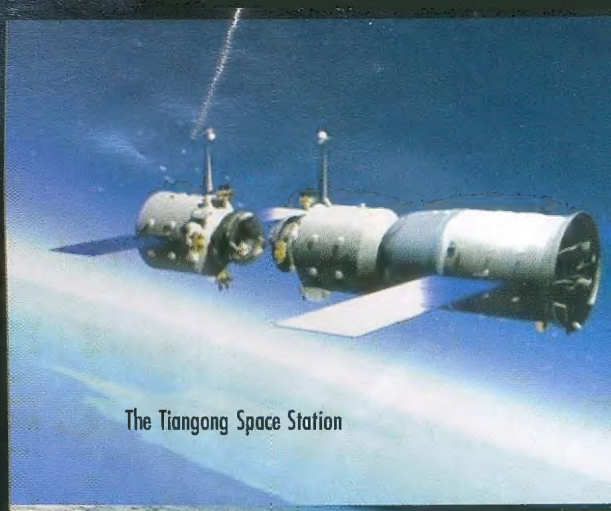
The *New Horizon* spacecraft is also presently on its way to Pluto and its moon Charon. It is the first mission to an icy heavenly body.

Destination Asteroid Belt

Another mission that is currently journeying through space is the *Dawn* mission. It is the ninth mission in NASA's Discovery Program. This mission has been sent by NASA, in collaboration with the Jet Propulsion

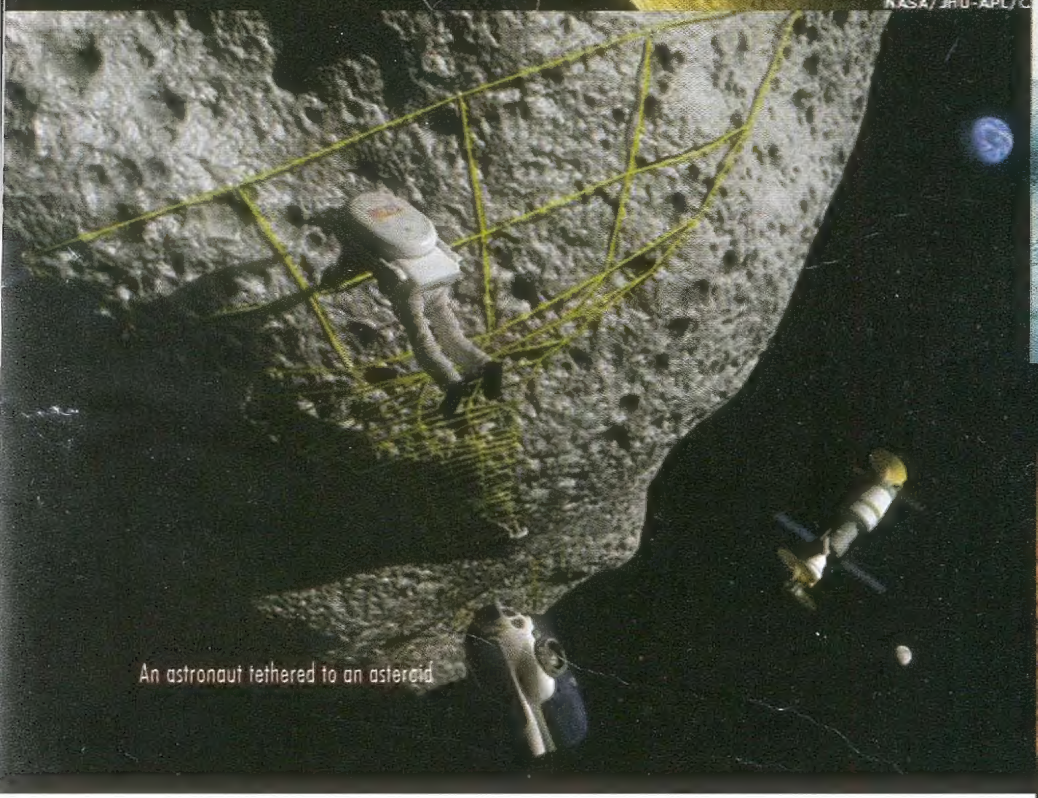
The MESSENGER spacecraft

NASA/JHU-APL/C



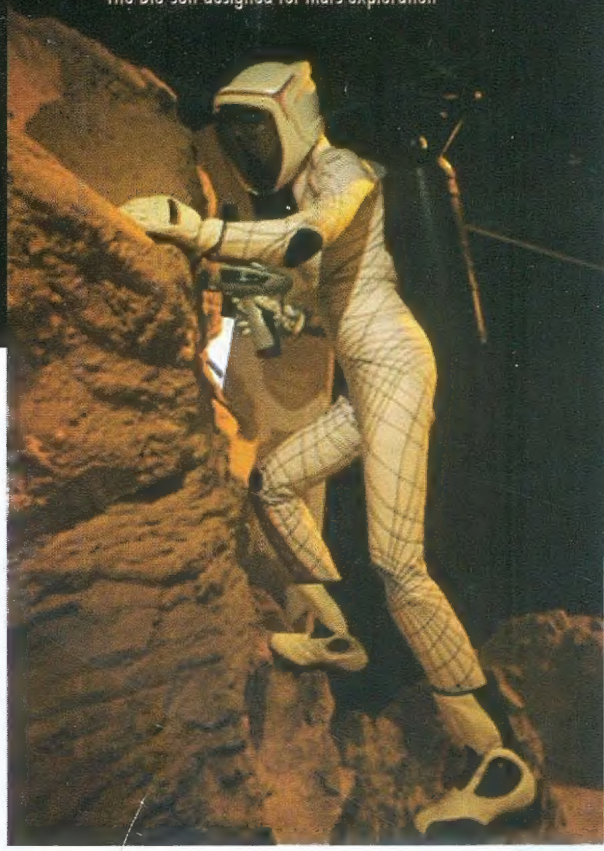
The Tiangong Space Station

A Bigelow Module



An astronaut tethered to an asteroid

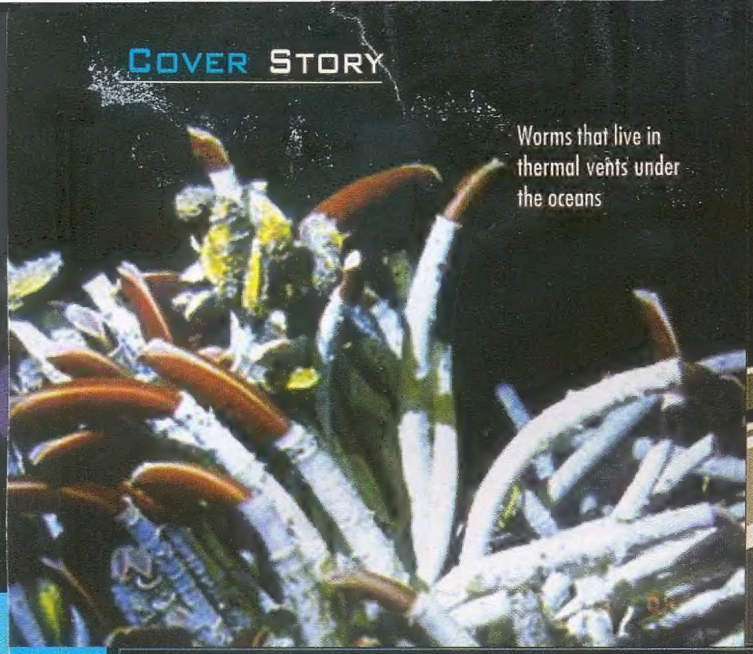
The Bio-suit designed for Mars exploration



Laboratory, California, to the asteroid belt between Mars and Jupiter, with the aim of gaining an insight into the early stages of the solar system. *Dawn* will orbit two of the largest asteroids, Vesta and Ceres. This makes *Dawn* the first spacecraft to orbit two separate bodies.

The *Dawn* spacecraft took off from earth in 2007. It then flew towards Mars. When passing Mars in 2009, it received a boost to its velocity from Mars' gravitational field. It reached Vesta in July 2011. It is due to take off from Vesta in June 2012 and start its journey towards Ceres.

The day is not far away when humans set foot on and maybe even have settlements on other planets. And maybe someday we will 'reach for the stars', literally.



Worms that live in thermal vents under the oceans

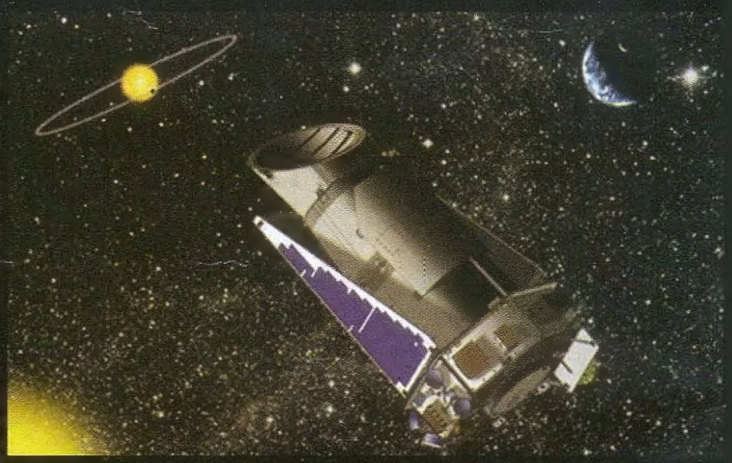
An artist's impression of a Space Elevator

NEW EARTH-LIKE PLANET FOUND

THE Kepler Space Telescope, which is the tenth mission in the Discovery program, has recently discovered a planet that has high chances of supporting life. The planet, named Kepler-22b, is in the habitable zone around a star very similar to the sun. Habitable zone refers to the narrow band around a star where water can exist as a liquid. Kepler 22-b also has a temperature which is conducive to life as we know it.

While the Kepler Telescope can identify planets that may support life, it is not capable of searching for life.

SETI, the Search for Extra Terrestrial Intelligence, which had shut down due to a lack of funds is now back in operation again. The Allen Telescope Array (ATA) will be searching the planets found by the Kepler Telescope for signs of life.



The Discovery program of NASA aims to enhance our understanding of the solar system by studying the planets, their moons and comets and asteroids. Vesta and Ceres were chosen for this mission because they are two very unique asteroids. They are two of the oldest bodies formed in the solar system. They are the two most massive asteroids and would have probably become planets if it wasn't for Jupiter's enormous gravitational influence.

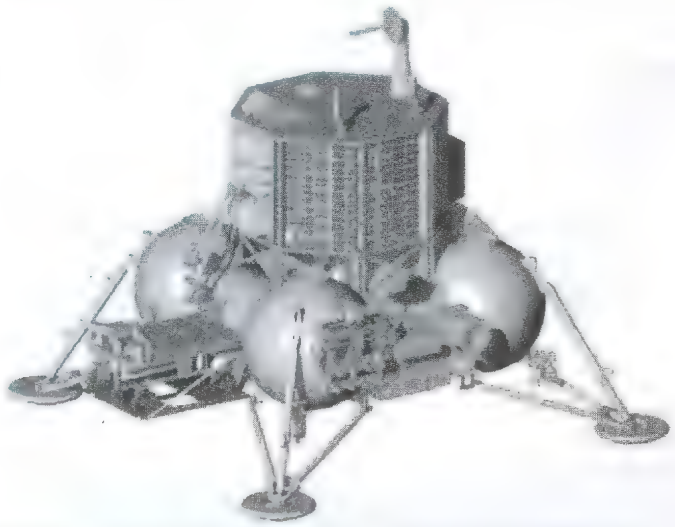
The characteristics of Vesta and Ceres are quite different from each other. Ceres has the potential to have water-ice on it. It has a clay-like surface, water bearing minerals and may have a weak atmosphere. Vesta, on the other hand, is a dry body. It was probably shaped by volcanic activity and has a layer of basaltic dust. Many meteorites from Vesta have come to earth and so we know a little about Vesta's composition.

Vesta's characteristics are more like the inner planets while Ceres resembles the outer planets. Scientists hope that by studying the two they can understand more about the change from inner rocky planets to outer icy planets.

Like the MSL, *Dawn* will carry cameras to take pictures and spectrometers to identify elements present in the outer layers of the bodies. It will also measure the gravitational fields of the asteroids to help better understand the internal compositions. It is powered by two large solar panels. The energy collected is used to ionize the fuel, xenon, that it is carrying, powering the mission.

Dawn will orbit Vesta several times, allowing it to study most of its surface. After

The Allen Telescope Array



CHANDRAYAAN 2

Chandrayaan 2 is the second lunar mission planned by ISRO. It will have an orbiter, a lander and a rover. The Russian Federal Space Agency (RKA) will provide the lander, the rest will be developed indigenously. The orbiter will orbit the moon at an altitude of around 200 km. The rover will roam the surface, collect samples of soil or rocks, analyze them with a spectrometer and send the data to the orbiter to be relayed back to Earth. The orbiter itself will also carry some scientific instruments that will map the elements present in the moon's surface and look for water.

leaving from Vesta in 2012, *Dawn* is supposed to reach Ceres in 2015.

If the mission is a success then we will have gained a lot of insight into the shape, size and composition of both these protoplanets. We will also be able to verify if the howardite, eucrite and diogenite meteorites have come to earth from Vesta and understand their geological history. We will also know more about the role of water in the evolution of asteroids.

Other Missions

The seventh mission in the Discovery program, the Messenger spacecraft is also currently orbiting Mercury. Messenger stands for MErcury Surface, Space ENvironment, GEochemistry and Ranging.

The biggest challenge when sending a mission to mercury is the intense heat. A sunshade has therefore been added to protect the probe from the intense rays of the sun. Messenger will also photograph Mercury and collect data about its composition.

China has planned to put a man in space again this year. Two missions, the Shenzhou 9 and 10, are scheduled to be launched this year. Both of them may be manned and at least one of them will be. Shenzhou 10 will probably be manned, and in fact China's first woman astronaut or 'yuhangyuan' may be aboard it. But the identities of the astronauts have been kept under wraps so far. Both these missions will perform dockings at the space station Tiangong 1.

ISRO, the Indian Space Research Organisation, is planning to launch a spacecraft named 'Aditya' sometime this year or the next, a period of high solar activity. It will orbit the earth at an altitude of around 600 kilometres. Its aim is to study coronal mass ejections, the phenomenon of the solar corona emitting plasma, which results in disturbances in the coronal magnetic field.

ISRO is also working on the Chandrayaan 2, another moon mission, which will probably be launched in 2014 (see box).

Space Tours?

Apart from these spaceflights of academic interest, Virgin Galactic will probably start its space tourism programme sometime in 2012. They have already started taking bookings. NASA, on the other hand, has had to cut down on its commercial spaceflight idea because of a budget cut.

Hotel entrepreneur Robert Bigelow even predicts that hotels will come up in space within this decade! These will give people the unique experience of living in zero gravity and maybe they will provide exciting new types of adventure sports. Not to forget that the view would be incomparable to any on earth.

Has the Future Arrived?

The year 2011 marked the end of NASA's space shuttle programme. After 30 years of shuttling to and from space stations, the shuttles have been retired and put on display at national museums in the USA (see *Science Reporter,* September 2011 for more details). It truly is the end of an era.

Now what does the future portend for space travel? The future of space travel will aim to find life in the solar system, send human missions to various destinations in the solar system and to eventually make human settlements wherever possible.

The moon is the body nearest to earth in the solar system and if humans go there and stay for a while then they would need to pitch a camp to live in. A company called Bigelow Aerospace, founded by Robert Bigelow, is already working on this idea. They have made an expandable module which can house six people and can be joined together to make a bigger living complex.

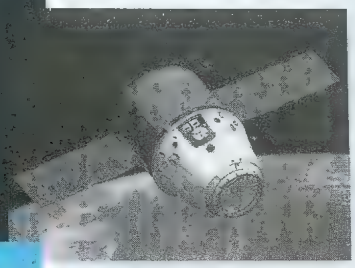
Another seemingly impossible idea that engineers are working on is the lunar elevator. A cable, thousands of kilometres long, suspended from the moon would be connected to a spacecraft and things could be ferried to and fro between them.

Humans are also aiming to visit asteroids. US President Obama has set sight on achieving this aim by 2025. Asteroids being much smaller than the planets, their gravity is much less and astronauts could float away into space. To keep them tethered down to the surface, scientists are thinking of a net bolted to the asteroid's surface, holding on to which the astronauts can walk around.

A factor that could limit human space exploration is the space suit astronauts have to wear. Previous suits like the ones we have seen were heavy and stiff and limited movement. A new, lighter suit has been developed by NASA team member Pablo de Leon from Argentina. The suit shall be ready for use by the time a manned Mars mission sets off. It is being tested in various environments like the Australian outback and the Antarctic to see if it can endure all the extreme conditions of Mars.

CRITICAL SOLAR ANGLE

SOLAR beta angle is the smaller angle between the orbit plane of the body (e.g. a satellite or space shuttle) and the vector drawn from the sun to the earth. It can vary between -90° to +90° and its sign is determined from the direction of the revolution of the satellite around the body or in this case earth. If the satellite is revolving in a counter clockwise direction around the earth with respect to the sun, the beta angle is defined as positive and vice-versa. This angle keeps changing as the earth moves around the sun and the orbital plane of the satellite changes due to the equatorial bulge of the earth.



The satellite heats up when it is facing the sun or is in the sunlight and excess sunlight can overheat the satellite and cause damage. The amount of sunlight received by the satellite depends on the solar beta angle. When the solar beta angle is less than 60°, the satellite spends tolerable amount of time in sunlight and cools down during nighttime. But when the beta angle is more than 60°, the satellite might get overheated and various thermal problems may arise that might disrupt the functioning of the equipments. Therefore, when the beta angle is greater than 60°, the satellite is said to be in the *solar beta angle cutout* period.

To overcome the overheating problem, satellites generally do a slow barrel rolling motion to keep the sun from overheating one side. This is also known as *barbeque* mode as it results in more even heating of the body. This technique has been used in previous lunar missions to cool down the propellant tanks of the space shuttle.

When the shuttle is docked to the ISS, it cannot do barrel roll ups so the whole station needs to be in the beta angle of less than 60°. The shuttle visits normally extend up to two weeks, which means there should be at least a two-week window of continuous solar beta angle of less than 60° at the ISS. When the ISS is itself in the solar angle cutout range, several measures are taken to counter the thermal effects that are not possible when the shuttle is docked to the station.

The station orbit is inclined at 51.6° from the equator, which needs to be taken care of while calculating the beta angle for the shuttle. Normally the ISS is located in Local Vertical, Local Horizon (LVLH) attitude like an airplane. As the beta angle increases, the solar rays fail to produce adequate power. In that case, the ISS changes its orientation with its x-axis perpendicular to the orbital plane thus augmenting the power generation. Since the high beta angle increases the thermal concerns to the installed equipment, the ISS is oriented in such a way that it receives sufficient sunlight for the power generation and can keep rolling at the same time to avoid excessive heating up on one side.

Generally large beta cutout periods occur only during few times a year, especially near summer and winter solstice, i.e., when the earth's axis of rotation is tilted nearest or farthest from the sun. Great precaution needs to be taken while calculating the launch dates and times. The solar beta angle also depends heavily on the time of the day the shuttle is launched. It might see a beta angle close to 0° if launched at noon and a beta angle close to 90° if launched near sunrise or sunset. The lighting conditions also change the experience of the astronauts. Sometimes the satellite is always at the terminator line which is a fictitious line dividing the illuminated day side and dark night side on the surface of the earth. This twilight region may last for several days for the satellite.

ISS service orbiter called *Endeavour* was grounded until 11 July 2009 because of the solar beta angle cutout from 3 July to 13 July 2009. It takes three days for the space shuttle to reach the ISS so it was finally launched on July 11 to avoid the high beta angle regime. Most recently, the STS-133 launch was delayed until February 2011 due to the month long solar beta angle cutout from 1 January to 1 February 2011.

Although, mainly technical difficulties, for example, the hydrogen leak on the pad of NASA's STS-127 mission, or the busy schedules of ISS traffic contribute to the delay of shuttle launches, solar beta angle cutout remains a major factor in determining the possible launch date and times of the space-crafts.

Contributed by Ms Swati Saxena, c/o Dr. Ashok Saxena, 204, Narain Towers, Sanjay Place, Agra-282002

A professor at MIT, Dava Newman, has also designed a bio-suit that is less bulky and she thinks it could be suitable for Mars exploration. The suit's tight stretchy material maintains pressure without constricting movement. A big bonus of this suit is that if you tear it, pressure decreases only around the tear. In the normal old suits a tear would mean a gas leak that would be a major emergency for the astronaut.

Apart from Mars, humans have identified Jupiter's moon Europa as being the most likely place in the solar system where life might be found. Europa has oceans under its surface. Given the discovery of giant worms that live under the ocean in thermal vents and microbes that live in lakes under the Antarctic ice on earth, scientists hope similar life forms can be found there. Stone Aerospace in Texas, USA is developing a robot that will navigate the Antarctic seas and they hope that a version of it can be sent to Europa someday.

With all these exciting developments, the day when humans set foot on and maybe even have settlements on other planets, may not be far. And maybe someday we will 'reach for the stars', literally.

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IMMUNE PRIVILEGED SITES

One of the basic principles in immunology is the capacity to distinguish self from non-self (foreign). Immunological response occurs for foreign macromolecules (antigens). If transplantation of a tissue/organ is done within the same individual, there is no rejection. At the same time if it is done within the same species or from one species to another, rejection occurs. Certain s introduction of antigens without eliciting an immune response. This tolerance is what is known as immune privilege. There are well known privileged sites in the human body like cornea of the eye, the uterus, the testis and the brain.

Immune privilege is thought to be an evolutionary adaptation to protect vital structures from the potentially damaging effects of an inflammatory immune response. Inflammation in the brain or eye can lead to loss of organ function, while immune response directed against a foetus can lead to the loss of the child.

The fact that cornea is normally devoid of both blood and lympthatic vessels has been termed cornea angiogenic privilege. During evolution, the cornea has developed mechanisms for preventing and modulating inflammatory angiogenic reactions. HLA-G protein is thought to contribute to the maintenance of the privileged immune status of this organ.

One tissue that is repeatedly grafted and repeatedly tolerated is the mammalian uterus. The mysterious lack of rejection of the foetus has puzzled generations of reproductive immunologists and no comprehensive explanation has yet emerged. Some explanations have been given to account for the tolerance normally shown to foetus.

Women who have borne children usually have antibodies directed at the father's MHC proteins. However, the placenta which is a foetus derived tissue appears to sequester the foetus away from the mother's T-cells. One factor that may contribute to maternal tolerance of the foetus is the secretion of cytokines at the foeto-maternal interphase. These cytokines tend to promote TH2 responses. This response is associated with anti-inflammatory cytokines and antibody formation.

The placenta has high levels of tryptophan degrading enzyme depleting tryptophan essential for T-cell activation and growth. It is also believed that an alpha-foetal protein, synthesized by the yolk-sac and foetal liver, has immune suppressive properties.

Sperms are foreign to both the man who produces them and the woman who receives them. In normal life, the sperms are kept away from blood stream by the blood-testis barrier formed by the sertoli cells in the testis. Besides, semen also contains immune suppressive agents secreted by the seminal vesicle. Breach of the blood-testis barrier that may occur due to infection or injury, may lead to the formation of anti-sperm antibodies in man.

In normal women, during copulation, sperms are deposited in the vagina and they reach the uterus within minutes. The acidic environment in the vagina kills the remaining sperms. Under normal circumstances the sperms do not gain access to the blood stream and hence do not lead to an immune response.

Testis is another immunologically privileged site that retains its privilege even when relocated by transplantation to other sites in the body. This implies that testis has some intrinsic properties rather than a physical barrier preventing access by cells of the immune system. Experiments have revealed that testicular tissue expresses high levels of FAS-ligand (FAS-L) and this protects the tissue from attack by T-cells which are killed through ligation of FAS.

Brain is also another immunologically privileged site probably because it does not have lymphatic vessels and because the walls of blood vessels in the brain differ from blood vessel walls elsewhere in the body (the blood-brain barrier). Certain capillaries permit some substances to pass from blood into the brain but restrict others. These capillaries are less permeable than others within the body and therefore more selective in passing materials. Only lipid-soluble substances can cross blood-brain barrier. Glucose and amino acids are not lipid-soluble but they can be transported by special transport mechanisms.

Dr. K. Venkataraman, Retd. Reader in Zoology, Madura College. Address: A-T-2 Porkudam apartments, Bypass road, Madurai-10

DOCTORS generally suggest a combination of antibiotics, antacids and multi-vitamin tablets for most of the common bacterial infections. The main reason behind this is that oral administration of antibiotics affects not only the disease causing microorganisms, but also increases the acidity of the stomach, causes disruption of intestinal flora, and suppresses the B complex vitamin synthesizing bacteria present in the mucosa of stomach and intestine.

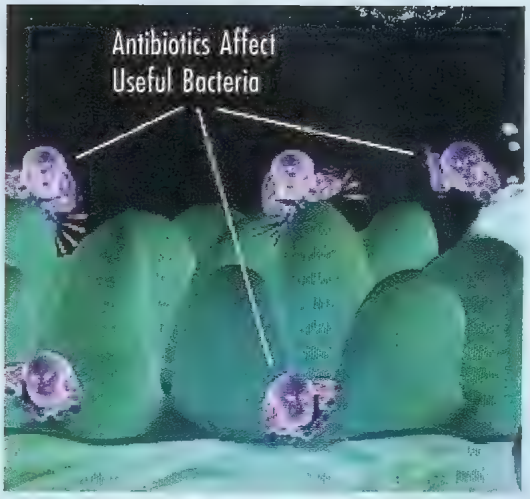
The decrease in pH of stomach leads to indigestion which is the primary cause of ulcers. To stabilize the pH of the stomach, an antacid is given along with the antibiotic. The deficiency of B-complex synthesizing bacteria causes mouth-ulcers and cracking of lips. To recover and balance

POWERFUL TELESCOPE INSTALLED

ARIES has successfully installed a 130-cm optical telescope at Devasthal, Nainital. The Rs 140-crore Devasthal Optical Telescope will be more powerful than the optical telescope at Girawali (near Pune) under the Pune-based Inter-University Centre for Astronomy and Astrophysics (IUCAA), Bangalore-based Indian Institute of Astrophysics's telescope at Hanle in Leh and Vainu-Bappu observatory at Kavalur in Tamil Nadu.

The cost of the Devasthal telescope is about Rs 120 crore, out of

WHY DOCTORS PRESCRIBE COMBINATION OF ANTIBIOTIC, ANTACID AND MULTI-VITAMIN

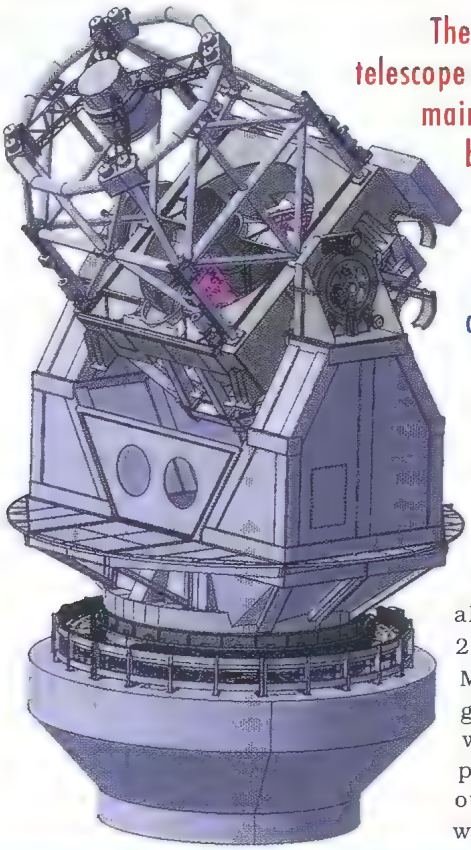


those suppressed B-complex vitamins, doctors suggest multi-vitamin tablets along with antibiotics and antacids.

Antibiotics target the bacterial cell wall, cell membrane or interfere with essential bacterial enzymes and lead to adverse effects that range from mild to very serious depending on the antibiotics used. They cause disruption of intestinal flora, resulting in overgrowth of harmful bacteria in the intestine. Antibiotics directly affect the digestive tract by decreasing the pH of stomach leading to digestive upset. Antacids are used to neutralize the extra acid produced in the stomach. Antacids and acid reducers can relieve pain or an uncomfortable feeling in the stomach. For treatment of peptic-ulcers, antacids may be used together with antibiotics.

Antacid tablets do a neutralization reaction by increasing the pH to reduce the acidity of the stomach and digestive upset. Multi-vitamin tablets are intended to supplement a diet with nutritional elements. Multivitamins can be a valuable tool to correct dietary imbalances and reduce vitamin deficiency.

Contributed by Dr P.K. Dubey and Mr S.S. Praveen Kumar Darsi, Department of Chemistry, College of Engineering, Jawaharlal Nehru Technological University Hyderabad, Kukatpally, Hyderabad-500085 (AP); Email: pramoddubey7@gmail.com; dpraveenjntu@yahoo.co.in



The 104-cm optical telescope is being used as a main observing facility by the ARIES scientists since 1972. The cost of the Devasthal telescope is about Rs 120 crore,

which the Belgium government is sharing about Rs 15 crore (Two million Euro). Located at an altitude of about 2,400 metres above MSL, the site is as good as some of the world's best sites. In partnership with other telescopes, it will offer astronomers a chance of watching an object continuously for 24 hours.

The unique position of Devasthal telescope (Longitude 79° East), places it at almost in the middle of 180° wide longitude band, between Canary Island (Longitude 20° West) and Eastern Australia (Longitude 157° East), and therefore complements observations that might not be possible from either of these two places due to daylight.

Devasthal telescope will also act as a complimentary platform to the Indian Space Research Organisation's Astrosat satellite, scheduled to be launched in 2012. Astrosat will be India's first dedicated astronomy satellite.

Astrosat would observe some objects from space, in X-ray, ultra-violet and radio wave lengths. Astronomers working at Devasthal Observatory would be able to study the same objects from the ground in the optical range.

The Institute has two smaller telescopes of apertures 56-cm and 104-cm at Manora Peak in Nainital. There are two 15-cm telescopes dedicated for solar obs
cm optical telescope is being used as a main observing facility by the ARIES scientists since 1972.

Contributed by Mr G.V. Joshi, E-2/11 Girijashankar Vihar, Karvenagar, Pune-411052

DONATE WHOLE BLOOD OR PLATELETS

THE importance of blood donations in life-threatening situations like accidents, cancer, organ transplants and heart surgeries cannot be denied. But have you ever wondered why we just cannot donate a part of the blood, for example, RBCs or blood platelets only instead of the whole blood. It is well known that in cases of Dengue it is the platelet count in the patient that goes down and the patient recovers as soon he is transfused with fresh blood platelets from a matching donor. In such a scenario it makes sense to just do a transfusion of platelets to such patients instead of using the whole blood thereby saving some vital blood components.

Recently a technology called "Pheresis" or "Apheresis" has enthused the hematologists of the world. "Plasmapheresis" means plasma separation from whole blood. Other components can be separated by plateletpheresis, leukapheresis and erythrocytapheresis. This technique is a special kind of blood donation where, for example, platelet or a single blood component is separated by a machine and the rest of the blood is returned to the donor's body. How is this achieved?

In a medical facility in South Dakota, USA, and other places worldwide this technology is being used to successfully benefit both donors and receivers of blood components. First, the three components of the blood viz. plasma, platelets and RBC, are separated from the whole blood. One pheresis donor can give concentrated platelets which otherwise would have required about five or six whole blood donors. The platelets are donated and the RBC and plasma is returned to the donor. This process just takes one needle stick and approximately 90 120 minutes. The same method can be used to collect apheresis RBC red cells are collected while plasma and platelets are returned to the donor.

People are being encouraged to donate blood components with availability of such technologies. The process itself is done in a relaxed atmosphere where the donor watches movies and reads to relax while donating. The donor by giving just the platelets is able to recover fast within a couple of days. Platelets can be taken about 24 times in a year by a single donor whereas the same donor can donate whole blood once in three months only as it takes longer to replace. Exposing a patient to 6 to 8 whole blood donors is also risky. Therefore apheresis minimizes the risk to the patient by exposing him to a single donor.

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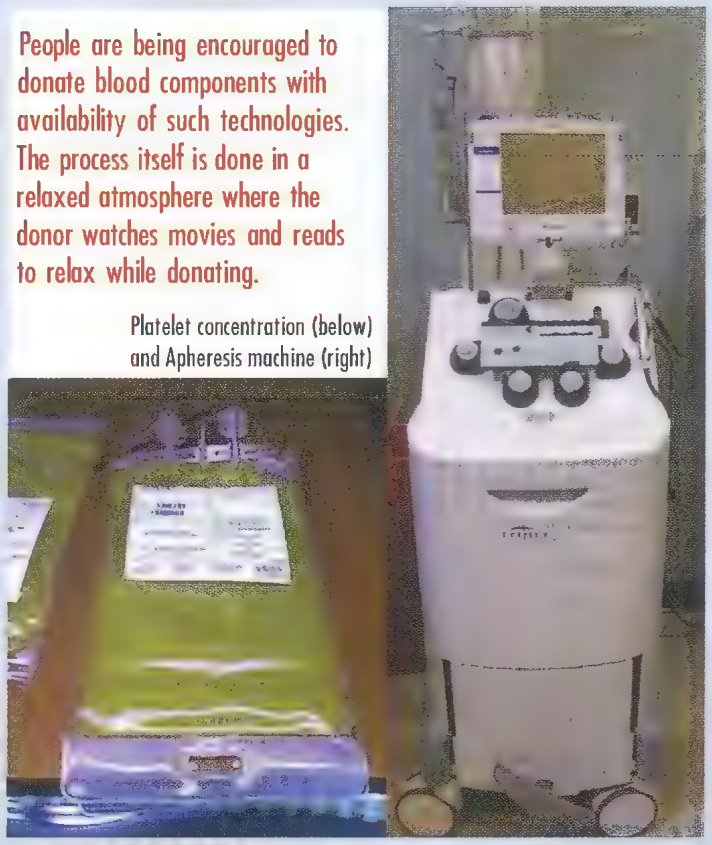

Platelet concentration (below) and Apheresis machine (right)

What are platelets and how are they useful for the human body? It is interesting to note that platelets in blood have a life span of only 5 to 8 days. When it is in short supply it can lead to internal bleeding and when they increase it leads to a condition called thrombocytosis. Therefore, platelets are important in humans for blood circulation and are involved in hemostatsis. Platelet derived growth factors (PDGF) released by platelets play a vital role in repairing and regenerating tissues in the body. Other growth factors released by the platelets like fibroblast growth factor, epidermal growth factor, etc are involved in the healing processes.

Platelets are formed in bone marrow by budding off from megakaryocytes. Each megakaryocyte is capable of producing between 5,000 and 10,000 platelets. When new ones are formed the old platelets are destroyed by the process of phagocytosis in the spleen and by Kupffer cells in the liver. However, reserve platelets are stored in the spleen, and are released when needed by contractions in the spleen. Seriously ill patients often require multiple transfusions because of the short span of the platelets.

So, in many cases, like organ transplants, patients require only platelets to survive. Pheresis technology is thus a boon for such patients and also benefits them. Such blood separator machines are available in our country also and being used to help people with blood related conditions.

Contributed by Dr (Mrs) Soumana Datta, Assistant Professor in Botany in the University of Rajasthan, Jaipur. Address: 2 Gopinath Garden, M I Road, Jaipur-302001; Email: soumanadatta@gmail.com

Inculcating Scientific Temper into National Consciousness

HASAN JAWAID KHAN

International Conference
on
Science Communication for Scientific Temper
10-12 January 2012, New Delhi
CSIR-NISCAIR, Vigyan Prasar, NCSTC
International Conference on Science Communication for Scientific Temper

Inaugural Session of the Conference. On the dais from left: Mr. Mahesh Bhatt, Dr. Gangan Prathap, Justice Markandey Katju, Dr. P.M. Bhargava, Dr. Subodh Mahanti

Prof. Samir K. Brahmachari, DG, CSIR, in his valedictory remarks observed that scientists should themselves demonstrate scientific temper in their day-to-day activity

THE Indian missile programme recently notched up an impressive record by firing the Agni IV missile at a target 3,000 kilometres away. The country's space programme, meanwhile, has set its sights on landing an Indian on the moon possibly by 2020.

But, cut to a village in Sangli, Maharashtra and you find villagers following a bizarre ritual – throwing infants down into a 50-feet deep well with the belief that it would help increase the life of the kids! Meanwhile, in a remote village in Andhra Pradesh, somewhere near Hyderabad, a piglet that happened to stray into the precincts of a temple is being worshipped as a divine incarnation. In other parts of the country, women are burnt on suspicion of being witches and children are killed on the advice of *tantriks* promising good fortune and wealth.

Is it acceptable for a country to have pockets of brilliance while a major part of its populace continues to wallow in ignorance and superstitious beliefs? Why have our efforts at inculcating scientific temper not given the desired results even after 64 years of independence? What, after all, is scientific temper? Can it be taught and inculcated later in life?

These and many other issues were thrashed out at the *International Conference on Science Communication for Scientific Temper*, recently held in New Delhi during 10-12 February 2012. The three-day international conference was a joint effort of the CSIR-National Institute of Science Communication And Information Resources (NISCAIR), Vigyan Prasar and the National Council of Science & Technology Communication (NCSTC), Department of Science & Technology.

From top left : Dr. Gangan Prathap, Dr. Mylswamy Annadurai, Dr. R. Chidambaram, Dr. Steve Fuller.

Left: Gauhar Raza with Film maker Shri Mahesh Bhutt during the proceedings.

Dr. Mylswamy Annadurai, Director of the Chandrayaan Project, said there was a need to spread scientific temper among the youth of today.

While Justice Markandey Katju, Chairman, Press Council of India, was the Chief Guest at the inaugural function, the other key speakers were Dr P.M. Bhargava, former Vice Chairman, National Knowledge Commission; Prof. Bernard Schiele from the University of Quebec, Montreal and noted film producer Mr Mahesh Bhatt.

Inauguration

In his inaugural address, Justice Markandey Katju set the stage for the conference by remarking that as long as the country was on the scientific path it prospered, but when we took to the unscientific path of superstitions and empty rituals we fell far behind the Western countries in science. This was the real cause of our poverty and other social evils. Inculcating scientific temperament on a massive scale is the need of the hour, he said. The way out for our nation is to go back again to the scientific path shown by our great ancestors such as Aryabhatta and Brahmagupta, Sushrut and Charak, Ramanujan and Raman.

Justice Katju stressed on the need to spread a scientific outlook and rational and logical thinking among our masses to enable them to give up backwardness and superstitions. He said, we need more democracy, not less, which would mean educating the masses, raising their cultural level and involving them actively in the task of national reconstruction. Justice Katju maintained that democracy and science go hand in hand—scientific growth requires values such as freedom to think, to criticize, to dissent and free flow of information, which were precisely the values of a democratic society.

Dr P.M. Bhargava, former Vice Chairman, National Knowledge Commission, in his presidential remarks talked about a study he conducted on 1000 people asking them what they would do if a black cat crossed their path 70% of the people, mostly the educated and financially secure, said they would change their path. This is the state of scientific temper in India, he said.

Dr Bhargava said that Pandit Nehru's commitment to scientific temper and his belief that the country could progress only on the basis of science and technology was well known. He even became the president of the Association of Scientific Workers of India, an association that Dr. Bhargava helped set up.

He said that we keep talking about scientific temper, but what do we mean by it? Understanding the basic methods of science is scientific temper. Scientific knowledge is verifiable, repeatable and falsifiable. It keeps on changing and there is no ultimate truth. There has to be a realization, he said, that using the methods of science is the only reliable way of dealing with problems, not by invoking supernatural powers. But promoting scientific temper among the masses is not going to be easy. He said that there was a need for a dedicated Indian science

television channel to dispel such irrational beliefs and promote scientific temper.

In his keynote address, "Science Communication: New World, New Challenges", Prof. Bernard Schiele from the University of Quebec, Montreal touched upon the science-society dynamic, how science was communicated in the past and what are today's challenges. He stressed the need for participation and dialogue processes in spreading scientific temper. He said that today we live in a world that is more difficult to decipher. We have a public that is much better informed but certainly not convinced. The public has become cautious, skeptical and distrusting, he said.

Prof. Schiele remarked that today the diversification of means of communication had brought new actors to the scene—from scientists to amateurs. So there are now more actors than ever engaged in producing science news, with scientists and mediators representing but a small number of them. Therefore, constant negotiation and dialogue would be required if science communication is ever to make an impact, he said.

Mr Mahesh Bhatt, renowned film producer, was happy to be associated with a forum that hoped to re-ignite the fires of scientific temper in the hearts of every Indian. But inculcating scientific temper meant bringing in doubt. He said that "doubt", which has been looked upon by cultures as a sign of weakness, requires more courage than conviction. The scientific temper that Jawaharlal Nehru crusaded for is born from a heartbeat, and that heartbeat is doubt. A society that is not decorous enough to concede that we are billions of times more ignorant than knowledgeable is doomed, he said.

However, Mr Bhatt stressed that even the scientific community needed to wake up and face the blunt truth that their uncritical faith in scientific knowledge had created many of the problems now threatening the planet; and our wholesale reliance on scientific progress is both untenable and myopic. He said that knowledge and insights accumulate fastest in the minds of those who hold an 'ignorance based' world view. Saying no two leaves or snowflakes are the same, he said, we need to recognize this uniqueness of every moment in every individual, to realize the true wonder of life.

Earlier, in his presentation Dr Gangan Prathap, Director-NISCAIR, tried to link the core concept of scientific temper with the various thought processes that prevailed in ancient India the Samkhyas, the Carvakas, the Jains and the Buddhists. In his presentation, "India's Many Trysts with Skeptical Humanism", Dr Prathap said that prevailing wisdom of those times believed that the removal of doubt using the instruments of reason and evidence, and the alleviation of suffering by compassion and humanism, were the most noble of all principles of right action. Thus, 2550 years ago, what the enlightenment philosophers re-discovered as skeptical humanism, was born in our part of the world, he said.

Dr Prathap said that even though it is widely claimed that it was the Greeks that invented science's golden rule – reason – on closer examination, we find that the first person that reliable written historical accounts give credit to for emphasizing the primacy of using reason to conduct ones life was from our own part of the world. Gautama Budhha had said, "Do not take the authority of the teacher or the text. Always, question yourself." He meant that one should not accept received wisdom but should always seek empirical evidence.

Thus, when India re-gained independence on the midnight hour on 15 August 1947, Pandit Jawaharlal Nehru promised that India would keep its tryst with destiny by enshrining the article of faith that called upon all "to develop the scientific temper, humanism and the spirit of inquiry and reform" (Fundamental Duties Articles, 51-A (h)).

Notion of Scientific Temper

In a session "History and Notion of Scientific Temper", Dr Dinesh Mohan, who played a part in the drafting of the 1981 'Scientific Temper Statement', said that the scientific temper statement preached the spirit of enquiry. However, he said that our society had today become more obscurantist. What we do or not do is all governed by our political ideology. Today, we can't even watch a movie, see a painting, an exhibition etc. that a section of people doesn't like. Even highly developed and scientifically advanced societies are killing thousands of people without listening to their point of view.

Dr Dinesh Abrol from CSIR-NISTADS said that after independence the feudal class pushed people towards faith because they wanted to maintain the colonial setup. He said when the ruling class establishes itself it does not appreciate the spirit of reasoning. A major role player in the Peoples Science Movement, Dr Dinesh Abrol said that PSM uncovered miracles and superstitions without actually attacking religion. PSM wanted science to be open to people and problems. He said that the basic philosophy of PSM was that science should be used as a tool *for* people not *against*.

Dr T.V. Venkateswaran from Vigyan Prasar stressed that if people have to participate in a healthy democracy then they need to understand the need for science and technology. They should have convincing arguments to say that nuclear power is necessary or not. He said that we need to draw upon science to question outmoded thoughts such as female foeticide, honour killings etc.

RESOLUTIONS ADOPTED AT THE "INTERNATIONAL CONFERENCE ON SCIENCE COMMUNICATION FOR SCIENTIFIC TEMPER"

Passing through the twists and turns of intellectual debates and empirical studies, during the past 30 years, the research on public understanding of science and science communication has matured. The house strongly feels that Indian experts and agencies should put together intellectual and material resources and take the lead to initiate focussed research on 'Scientific Temper'.

With the advent of new media and proliferation of science movements, the mass base for communicating science has enlarged many folds. Even the marginalised sections of stratified societies, who did not constitute the audience for science communication during the previous century, today, are being drawn into various debates on scientific issues. The house recognises that all the efforts made to communicate science, eventually, are directed towards spreading 'Scientific Temper' among the publics. However, the house also noted that a disjuncture, between the research outcomes and actual practice of science communication, exists and there is an urgent need to bridge the gap.

RECOMMENDATIONS

International Level

- Scientific temper as a notion cuts across traditional boundaries of natural sciences and includes disciplines such as arts, philosophy, and literature. Therefore, a transdisciplinary approach to scientific temper is required.
- There is an urgent need to establish synergy between research and actual communication of science. For this the level of discourse has to shift from 'scientific literacy'/'public understanding of science'/'public engagement of science' to creation of scientific temper among the publics at large.
- International community of experts should make concerted efforts to initiate and encourage scholars in developing countries to work on 'scientific temper'.
- Scholars and institutions in fast developing economies, such as India, China, South Africa, Brazil and Argentina, should deepen their cooperation and may institutionalise it through memorandum of understanding.
- In order to facilitate further research, a three-pronged strategy suggested earlier must be followed: inventory and compile existing databases; make these available on Open Access on Web; and create an inclusive network of scholars and communicators working in the areas of science communication, public understanding of science and science education.
- The efforts to communicate science through traditional and new media must be intensified and communicating science should be considered as 'public good'. Governments, especially in developing countries, must take the responsibility of running and financially supporting science communication activities.
- The transmitter model of communication should be shunned and

Electronic Media and Scientific Temper

While the electronic media can claim to reach the nooks and corners of the country, sadly, these media, especially television have also turned out to be the purveyors of irrational beliefs and superstitions. Driven as most television channels are purely by the lust for making huge profits, shows dealing with occult phenomena and superstitions are often jazzed up with special effects, screaming headlines and exciting story lines to lure people in.

The electronic media seems to have gone too far in their quest for TRPs. Unbalanced, sensational and unscientific TV programmes have a lasting impression on ignorant and gullible minds. But unmindful of all this, the electronic media persists with its staple of sensational ghost stories, alien landings and totally unfounded mystery claims. In fact, with their regressive themes such programmes run contrary to the spirit of the Indian constitution where inculcation of scientific temper is well enshrined.

This view was also reiterated in a session "Television and Scientific Temper" by the chairperson Dr B.S. Bhatia, former director, DECU, Ahmedabad when he said that television was propagating anti-scientific ideas widely. He stressed on the necessity for setting up a dedicated science channel that could disseminate authentic science information to the masses.

Speaking in the session, K.P. Madhu, a freelance science journalist said that the purpose of television was to inform, educate and persuade the masses but its focus was shifting these days on what to wear, what to use etc. E.R. Subrahmanyam said that several myths and superstitions still exist in our society and electronic media offer unexplored ways of eradicating these irrational beliefs from the society

Dr. R. Ramachandran, noted science journalist and Associate Editor, *Frontline* while chairing the session on "New Media and Scientific Temper" said that often the information provided by electronic media was not completely correct and raised unfounded fears among the public as happened in the case of eclipses or the Large Hadron Collider. Channels often are not concerned with the origin of the cause and how it can be dealt with. Once an issue arises they just screen it and that's the end of it. They don't go for deeper research. This was scary because visual media was overtaking print media very fast, he said.

Aparna Vaish from the All India Radio said that AIR reaches 99% of the Indian population and thus was an effective way of disseminating science. Speaking in the session "Radio and Scientific Temper", she said that AIR's reach had now become global through the Internet. P. Rajamanickam said that radio programmes could be instrumental in increasing the public understanding of science and inculcating scientific temper as they provided a forum to ask questions.

However, Manas Pratim Das from AIR, Kolkata pointed out that while FM channels focused mainly on music, there was little or no space for science programmes and no tradition of live science programmes. Citing the example of *Bigyan Rasiker Darbare*, the first live science programme that he initiated on AIR-Kolkata, Manas said that lucid explanations laced with humour was a good way to impress the listeners and attract them during live science programmes.

public should not be considered as ignorant-scientifically illiterate-clean slate, on which any scientific information can be written. Instead, all channels of communication, including science museums, extension centres, TV and radio channels must take the cultural-worldview of the target audience into cognisance.

- Science Movements led by the Civil Society organisation, at times, have divergent views on science and technology policies formulated by the governments. It is recommended that efficient channels for continuing dialogue between the two must be opened.
- Of late, there is a spurt in the anti-science and extra-science propaganda the world over, at times, specifically directed to spread unfounded fear among the masses. Scholars have a social responsibility to lobby and pressurise the Governments to formulate strict rules to deal with such propaganda.

National Level

- The house suggests that every country should strive for adoption of implementable government policies to spread scientific temper among its citizens specifically in the local languages.
- The house reaffirmed the earlier recommendation to establish research/teaching institutes dedicated to the furtherance of scientific temper having strong linkages with other cognate institutes/disciplines.
- Since scientific temper is a continually changing notion – in space and time – regular national and international consultations to review the developments are required. Efforts should be made to institutionalise these deliberations and the conclusions should be widely publicised.
- Regulatory bodies monitoring and auditing mass media such as print, radio and television should issue guidelines to create an atmosphere where individual citizens could perform their fundamental duties of spreading scientific temper, humanism, secular values and spirit of inquiry.
- The house noted that no national level study of 'scientific temper' has been conducted. It is strongly recommended that apex institutions in these countries must come together to carry out studies to measure national 'scientific temper' levels.
- In addition to common minimum indicators, region/country and culture/theme specific indicators of 'scientific temper' should also be developed and shared with other scholars for their benefit.
- We believe that spreading 'scientific temper' would strengthen the democratic spirit among the people to enable them to articulate their entitlements based on rational scientific temper.
- Specific efforts should be made to develop tools and materials to spread scientific temper.
- To promote scientific temper at the grass-root level, a web-based database should be created to document science communication activities – both successful as well as failures. Incentives and recognition to successful science communicators should be institutionalised.
- Each country should have a dedicated TV channel, exclusively to communicate science and a mechanism should be created to share resources without IPR restrictions.

Valedictory Session

The three-day International Conference on Science Communication for Science Temper concluded on 12 January 2012. The valedictory function was presided over by Dr R. Chidambaram, Principal Scientific Advisor, Government of India, while Prof Samir K. Brahmachari, DG-CSIR and Secretary, DSIR, delivered the Valedictory Remarks.

Justice Katju stressed on the need to spread a scientific outlook and rational and logical thinking among our masses to enable them to give up backwardness and superstitions.

Dr Chidambaram in his presidential remarks observed that science communication for scientific temper would work only if the information is true and comprehensible. He said that the right information was very important. Even illiterates could be thought to think rationally if given proper information, and even educated persons could be taught to think irrationally as was evident in the case of suicide bombers. Citing the example of the Kudangulam Nuclear Power Plant, he said, even though the nuclear power plant would fulfill the power demands of Tamil Nadu, it was facing resistance. The role of science communicators, therefore, was the most important, he said.

However, he cautioned against partial scientific literacy and said that science communicators should be careful while communicating science. Science communicators should also note that the publics are not merely empty vessels where they could simply dump their information. He said that communication increases knowledge, which in turn spreads economic well-being.

Prof. Samir K. Brahmachari in his valedictory remarks observed that scientists should themselves demonstrate scientific temper in their day-to-day. He also stressed scientific temper could be spread only by making our scientists the heroes. Unfortunately, today the heroes are players or film stars whose images are beamed into the living rooms through satellites made possible by scientists. He stressed the point that scientists should be given due value in society.

Dr. Brahmachari also said that rationality ends where knowledge ends, and it was from here that ignorance begins. Hence, there is a need to push the frontiers of knowledge and this is the primary duty of science communicators. Science communicators have the responsibility to motivate the young to question interpretations. He also called upon science communicators to harness the potential of social media like Facebook. The future lies in new cyberspace, he said.

In his brief remarks, Dr. Mylswamy Annadurai Director of the Chandrayaan Project, said there was a need to spread scientific temper among the youth of today. And this could be done only if we had role models. Everybody, including the parent can be a role model, he said. He also said that the objective of scientific temper should be to create an ambience so that people could take informed decisions rather than forcing information on them.

With inputs from Neeha V.S., Priyamvada Kinth, Neha Yadav, Kainat Parveen, Bilqeesa Bhat and Leela Ramamani – Research Interns at NISCAIR.

KUMAR AVINASH BHARATI

PLANT TAXONOMY

1. **The Eighteenth International Botanical Congress (IBC) was from 23-30 July 2011 at**
   (a) Melbourne (c) New Delhi
   (b) Paris (d) Berlin

2. **Which one of the following is the largest family in India?**
   (a) Rubiaceae (c) Fabaceae
   (b) Poaceae (d) Orchidaceae

3. **Which one of the following is the largest family in the world?**
   (a) Orchidaceae (c) Poaceae
   (b) Asteraceae (d) Rubiaceae

4. **The formation of pseudoembryo sac due to the disintegration of nucellar cells below the embryo sac is a unique feature of**
   (a) Ranunculaceae (b) Podostemaceae
   (c) Cyperaceae (d) Onagraceae

5. **Which one of the following family posseses Pollinia?**
   (a) Liliaceae (b) Zingiberaceae
   (c) Cyperaceae (d) Orchidaceae

6. **Which one of the following statements is wrong?**
   (a) Bentham and Hooker system of classification is based on de Candolle's system of classification
   (b) Engler and Prantl system of classification is based on Eichler's system of classification
   (c) Cronquist system of classification is based on de Jussieu's system of classification
   (d) Hutchinson system of classification is based on Bessey's system of classification

7. **The botanical name Malus malus is an illegitimate name because it is considered as**
   (a) Nomen nudum (b) Tautonym
   (c) Nomen dubium (d) Autonym

8. **Canavanine, a non-proteinic amino acid, occurs only in**
   (a) Fabaceae (b) Caryophyllaceae
   (c) Euphorbiaceae (d) Papoveraceae

9. **The development of similar features separately in two or more genetically and not closely related lineages and not due to a common ancestry is known as**
   (a) Convergence (b) Parallelism
   (c) Homology (d) None of these

10. **The material designated by the original author as the nomenclatural type is a**
    (a) Topotype (c) Isotype
    (b) Holotype (d) Neotype

11. **Different types of modifications of axillary buds (in Bougainvillea it is a spine, in Dioscorea bulbils and in Passiflora tendrils) are example of**
    (a) Parallelism (b) Analogy
    (c) Homology (d) None of these

12. **A branching diagram in the form of a tree used to depict degree of relationship or resemblance is known as**
    (a) Climagraph (b) Clastotype
    (c) Denizen (d) Dendrogram

13. **Which of the following statements is correct?**
    (a) Gynoecium is the female part of a flower
    (b) Pistil is the female reproductive organ of a flower, consisting of ovary, style and stigma.
    (c) Carpel is the female reproductive organ of the flower, consisting of the ovary with ovules.
    (d) Ovule is the female reproductive organ of the flower consisting of the megasporangium with integuments.

    Select the correct answer
    (a) 1, 2 and 4 (b) 1 and 2
    (c) 1, 2, 3 and 4 (d) 1, 3 and 4

14. **The botanical code stipulates that the name of every taxonomic group should end in a certain manner. Match them here.**

List I (Category)	List II (ending of names)
(A) Division	1. ales
(B) Class	2. -eae
(C) Tribe	3. -opsida
(D) Order	4. -phyta

    (a) A B C D (c) A B C D
    1 2 3 4 2 1 4 3
    (b) A B C D (d) A B C D
    4 3 2 1 2 3 1 4

15. **Consider the following types of classification:**
    1. Bentham and Hooker's system 2. Linnaeus' system
    3. APG III 4. Takhtajan's system
    5. Cronquist's system 6. Kubitzki's system

    The correct sequence of the chronological order in which these classification systems appeared is
    (a) 2, 1, 4, 5, 6, 3 (c) 2, 1, 3, 6, 4, 5
    (b) 1, 2, 4, 3, 6, 5 (d) 1, 2, 3, 4, 6, 5

16. **Match list I with list II and select the correct answer.**

List I (researcher)	List II (taxonomic work)
A. William Roxburgh	1. Flora .ndica
B. J. F. Royle	2. Flora of Kashmir
C. J. D. Hooker	3. Flora of British India
D. J. F. Duthie	4. Flora of Upper Gangetic plains and adjacent Siwaliks and sub Himalayan tract
	5. Illustrated flora of Delhi

    (a) A B C D (c) A B C D
    4 5 2 1 1 2 3 4
    (b) A B C D (d) A B C D
    2 4 3 5 2 3 4 1

17. **Match list I with list II and select the correct answer.**

List I (families)	List II (placentations)
A. Caryophyllaceae	1. Basal
B. Solanaceae	2. Parietal
C. Asteraceae	3. Axile
D. Cactaceae	4. Free central

    (a) A B C D (c) A B C D
    1 2 3 4 3 2 1 4
    (b) A B C D (d) A B C D
    2 4 1 3 4 3 1 2

ANSWERS

1.c	2.d	3.b	4.b	5.d	6.c	7.b	8.a
9.a	10.b	11.c	12.d	13.c	14.b	15.a	16.c
17.d							

Contributed by Mr. Kumar Avinash Bharati, Research Intern, NISCAIR, CSIR

BIBHUTI NARAYAN BISWAL

COMMON ACIDS WITH UNCOMMON FUNCTIONS

1. **Acid that is widely used in food preservation and fermentation industry. When it is allowed to freeze, it forms brilliant needle shaped crystals. The acid is:**
   a) Acetic acid b) Oxalic acid
   c) Malic acid d) Citric acid
2. **Our body proteins consist of functional unit (-CO-NH2) called amino acids. Identify the amino acid.**
   a) Crotonic acid b) Palmitic acid
   c) Succinic acid d) Phenyl alanine
3. **The acid that is mixed with baking powder used for baking of breads and cakes.**
   a) Tartaric acid b) Acetic acid
   c) Lactic acid d) Cinnamic acid
4. **Name the acid that is the essential starting material for protein production and is found in all living cells.**
   a) Ribonucleic acid b) Hydrochloric acid
   c) Nitric acid d) Uric acid
5. **The acid that is used as vitamin C**
   a) Ascorbic acid b) Palmitic acid
   c) Glutaric acid d) Carbonic acid
6. **Red ant sting creates swelling due to which acid.**
   a) Propionic acid b) Acetic acid
   c) Butyric acid d) Formic acid
7. **The acid found in the digestive juice and also widely used in industries**
   a) Nitric acid b) Hydrochloric acid
   c) Sulphuric acid d) Chromic acid
8. **Unripe apples and other fruits contain the acid called**
   a) Fumaric acid c) Citric acid
   c) Malic acid d) Tartaric acid
9. **The acid used in manufacture of explosives and rocket fuels**
   a) Hydrochloric acid b) Cinnamic acid
   c) Nitric acid d) Sulphuric acid
10. **Highly dangerous and corrosive acid with wide industrial application**
    a) Sulphuric acid b) Nitric acid
    c) Phosphoric acid d) Adipic acid
11. **Acid used for manufacture of ink and dyes with the help of microorganism Aspergillus niger is**
    a) Gallic acid b) Gibberellic acid
    c) Itaconic acid d) Koji acid
12. **Important acid that is required for the manufacture of antibiotics and insecticide is:**
    a) Gallic acid b) Itaconic acid
    c) Gibberellic acid d) Koji acid
13. **The common chemical found in tea and also widely used in tanning industry:**
    a) Hydrocyanic acid b) Carbolic acid
    c) Tannic acid d) Suplhuric acid
14. **The acid used for the manufacture of synthetic fibres, plasticizers and alkyl resins**
    a) Itaconic acid b) Malonic acid
    c) Salicylic acid d) Uric acid
15. **Beans are an excellent source of proteins. They mainly contain**
    a) Citric acid b) Malic acid
    c) Both a&b d) Succinic acid
16. **Banana contains predominant organic acid not found in any citrus fruits.**
    a) Ascorbic acid b) Malic acid
    c) Citric acid d) Tartaric acid
17. **Potato is the staple food of every human being. It carries the acid:**
    a) Malic acid
    b) Citric acid
    c) Oxalic acid and Phosphoric acid
    d) All of these
18. **Tomatoes are considered as the poor man's apple. The major acids in tomatoes are:**
    a) Tartaric and Phosphoric acid
    b) Hydrochloric and Sulphuric acid
    c) Fumaric and Galacturonic acid
    d) Citric and malic acid
19. **The very familiar household fruit grapes contain malic and tartaric acid along with traces of citric acid and oxalic acid. The proportion in which malic acid and tartaric acid are present is**
    a) 2:3 b) 1:3
    c) 2:1 d) 3:2
20. **Carrots used widely as vegetable and salads in India mainly contain:**
    a) Oxalic acid b) Succinic acid
    c) Fumaric acid d) Malic and citric acid

ANSWERS

1. a	2. d	3. a	4. a	5. a	6. b	7. b	8. c
9. c	10. a	11. a	12. d	13. c	14. a	15. c	16. a
17. d	18. d	19. d	20. d				

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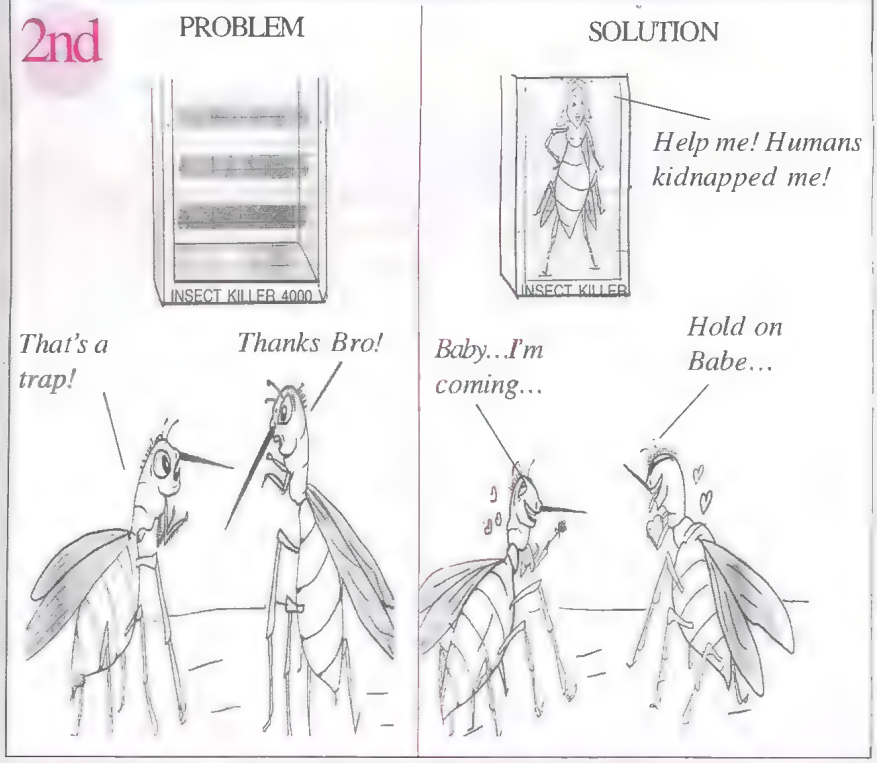
AJIT SINGH NEGI
HT-232, Neela Apartments, Near Gold Coins Club,
Andapura, Electronic City, Bangalore-560100

1st

PRAKASH BHAGMANT BHALAVI
Indian Oil Corporation Ltd., Research &
Development Centre, Sector 13, Faridabad-121007

GAURAV NANDI
MdTc Khadi & Village Commission, Udyogpuri, Gandamunda, PO Khandagiri, BBSR-30

2nd

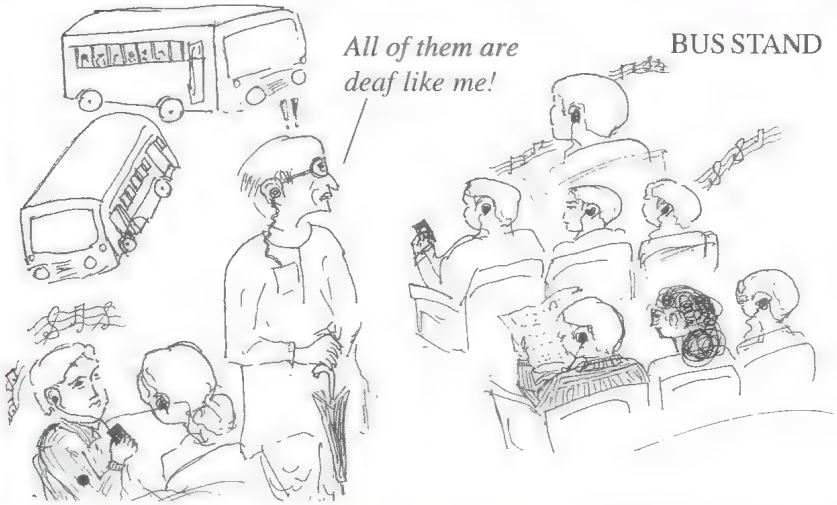


3rd

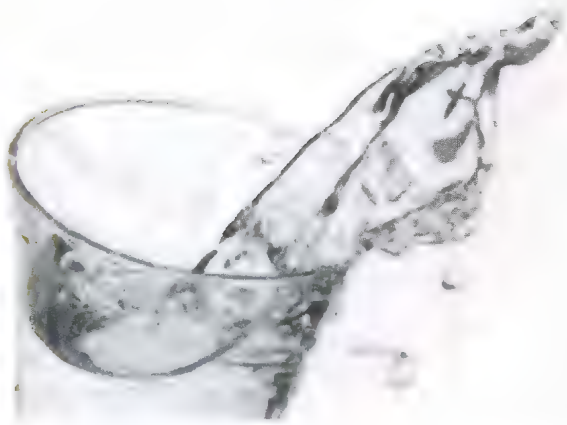
SAMYSANGHITA GHOSH
C/o Tapomoy Ghosh, Shibloon, Katwa,
Burdwan-713130 (WB)

4th

MOBILE/
MUSIC
MANIA



What's in Your Water?



SUDHAUNSHU PUROHIT

"**WATER** is life's mater and matrix, mother and medium" said the 1937 Nobel Laureate Hungarian biochemist Albert Szent-Gyorgyi. It is indeed the element that creates and sustains life not only on land but also under the dark unknowns of ocean depths. Indeed, the quest for water has taken man not only to the extremes of earth but now also to the lands beyond our planet. India's Chandrayaan I mission with the aid of NASA's Moon Mineralogy Mapper (M^3) in 2008 did yield critical data that provided irrefutable evidence of the presence of water on the moon.

Today as we cross the first decade of the 21st century, India's economy has soared at the rate of 8% every year for the last five years and is projected to be the second largest economy in the world by 2050. The growth has been fuelled by the innovations in the service sectors such as in the Information technology industry. However, the backbone of India's economy is still agriculture which accounts for 52% of total employment and nearly 15% of India's gross domestic product (GDP).

Given the dependence of such a large portion of India's GDP and labour on the four-month monsoon season, water storage and conservation is of paramount importance for our economy as well as the health of the nation. The government spends billions of dollars for water treatment and storage and distribution infrastructure to quench the needs of millions across the nation. Ironically, this most important resource is wasted everyday due to negligence and lack of awareness of the efforts and costs required by the government to provide water so economically for everyone.

In recent times, it has become even more important to closely guard the quality of water since it is one of the primary causes of the spread of infectious diseases. Furthermore, the threat of poisoning of our vast water resources by anti-social elements and terrorists has been a major concern of the administration. The development of new methods and devices for monitoring the quality of potable water therefore assumes great importance.

Concerns

One of the most common forms of water contamination is arsenic pollution. Arsenic poisoning is one of the major concerns that has worried scientists for quite some time. It has been nearly two decades since the Bangladesh tube well arsenic crisis. An efficient tool to monitor such toxic chemicals still eludes us. Large populations in various parts of the world are using potable water contaminated with arsenic concentrations much higher than the permissible levels (for most European countries and the United States, 10 μg/L; elsewhere, 50 μg/L).

Arsenic, along with fluorine, is now recognized by the World Health Organization (WHO) as the most serious inorganic contaminant in drinking water. Systemic and chronic exposure to arsenic is known to lead to serious disorders, such as vascular diseases (Blackfoot disease and hypertension) and irritations of the skin and mucous membranes, as well as dermatitis, keratosis, and melanosis. Inorganic arsenic is a human carcinogen. Hence, there is a need for analytical methods able to detect arsenic at very low concentrations, specifically, rapidly, and on the field.

Traditionally, various chemical and instrumental methods such as chromatographic and spectroscopic methods that can provide elemental analysis of all the contaminants in water have been widely used. However, these methods are expensive, time consuming, labour intensive and require software and skilled analysis. These drawbacks have limited their use to government agencies or developed countries. There is an urgent need of a diagnostic test that is cheap, portable easy-to use and that enables efficient and fast detection of toxic substances in tube wells, well water, lakes and other water sources in rural communities.

Advances in Detection Technology

So far, such technology was very difficult to come by. However, recently, researchers from University of Kentucky, USA, have developed a new method using living bacteria that glow with fluorescent light in the presence of arsenic. The path-breaking research done by Dr. Amol Date, a native of Mumbai, India, was published in top scientific journals (*Analytical Chemistry* and *Analytical and Bioanalytical Chemistry)* in 2007 and 2010 and has received widespread attention since then.

This new technology is not only extremely effective in detection but also inexpensive, easy-to-use and store.

Arsenic, along with fluorine, is now recognized by the World Health Organization (WHO) as the most serious inorganic contaminant in drinking water.

Systemic and chronic exposure to arsenic is known to lead to serious disorders, such as vascular diseases

The genetically engineered bacterium serves as a biosensor for arsenic in water and is programmed to glow bright yellow in colour only when it is in the presence of arsenic-containing water. The glow can enable even a layman to confirm the presence of toxins in water. Additionally, the bacteria can be converted to spores and stored and packaged for long periods of time without any special storage requirements.

Gram-positive bacterium (*Bacillus subtillis*) used in this research has been extensively studied as a model prokaryotic system. It is not regarded as a pathogen and is used in various applications such as a probiotic for both human and animal consumption. One unique feature of this bacterium is that it produces an endospore when starved of nutrients, as part of its developmental life cycle. The mature spore released from the mother cell can survive in a metabolically dormant state for hundreds, if not thousands of years without losing its viability. It has been claimed that one in 100,000 spores can survive a brief exposure to 3,000°C flame and can also tolerate liquid helium at -269°C. Under favorable conditions, spores can germinate and transform back into bacterial cells and resume their normal metabolic activities.

This new technology is not only extremely effective in detection but also inexpensive, easy-to-use and store. The new technology has also been shown to be integrated in chip-like devices by Dr. Date. The main impact of this work is that it has now jump-started the field of on-site analysis of environmental samples. Features such as integration of sensors into chips and ease-of-use, along with the low-cost of the technology have opened the doors to its use in developing countries and rural areas.

The implications of this research are not limited only to environmental detection but have also been shown to be useful in clinical applications. Specifically, the sensors were employed to detect micromolar amounts of zinc in blood samples of healthy subjects. This is of particular importance since zinc has been shown to be an influencing factor in Alzheimer's disease. The diagnostics chips envisioned by Dr. Date will be revolutionary to the detection field in medicine. This research was also recently highlighted by the US magazine *Popular Science* in February 2010 as "one of the Top 25 technologies that will transform our crumbling infrastructure."

As we move ahead in the twenty-first century, such innovations and technologies bring the promise of improvement in the health of millions of people. Many developing countries such as India therefore need to invest in research and development of technologies that will facilitate the surge in growth and prosperity of the country.

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Pharmaceuticals in Drinking Water?

H.K. PARWANA

FOR years people felt that they could keep their bodies free of dangerous chemicals by taking simple precautions like, eating organic & fresh food and by using natural cleansers like tulsi, neem, etc. However, today we know that they are wrong. Whenever tests are conducted to check for chemicals in people, plenty of chemicals are always detected. It does not matter whether they are old or young, newly born or even fetal, nor what their history is, chemicals are always found and pollution of our bodies is a universal fact.

Where do these chemicals come from? Today, chemicals are used in a seemingly endless array of industrial applications, agricultural practices and consumer products, including baby toys, air fresheners, detergents, clothes, furniture, etc. and last but not the least, as drugs/pharmaceuticals, commonly known as medicines.

And how do they get into our bodies? Through our food, tap & bottled water, indoor & outdoor air and many of the things we touch or put on our skin.

Over the past few years a lot of concern has been expressed over the presence of contaminants like pesticides, arsenic, fluoride and other chemicals in drinking water. To the list has been added the latest concern – the widespread presence of pharmaceuticals in drinking water.

Gone and Forgotten!

Forgotten yes, but not really gone.

There's no doubt about it, pharmaceuticals are being detected in the environment and there is genuine concern.

The topic first gained notice in Europe in the early 1990s when scientists first found a cholesterol-lowering drug in groundwater. Pharmaceuticals include chemicals like medicines, cosmetics, personal care products, as well as antibiotics and growth hormones used for animals. According to a WHO report, pharmaceuticals have been detected and confirmed in all components of the water cycle in Europe and have been raised as a concern by organizations such as the Rhine Water Works and wastewater treatment companies.

This information is not new to scientists in the field of water. Studies conducted in many parts of USA also point to a similar situation and a broad range of chemicals is found in surface waters especially downstream of urban areas. As per *CBS News,* pharmaceuticals have been detected in lakes, rivers, reservoirs and streams throughout the world. Studies have detected pharmaceuticals in waters throughout Asia, Australia, Canada and Europe – even in Swiss lakes and the North Sea.

Scientists are becoming increasingly concerned over the presence of prescription and over-the-counter drugs in water and their potential health impacts. It is now known that we are exposed to other people's drugs through our drinking water. The concern is also that people are ingesting mixtures of more than one drug (that were never meant to be taken) together, which makes matters even worse by causing drug interactions and side effects.

How do drugs get into the water? People take medicines and their bodies do not absorb all the medication, as about 90% of oral drugs pass through humans unchanged and get flushed down the pots. Animals also take medicines. Pets are treated for all types of illnesses and cattle are given hormones. Cattle are also given ear implants that provide a slow release of trenbolone, an anabolic steroid used by some bodybuilders, which causes cattle to bulk up, but not all the trenbolone is metabolized.

Other veterinary drugs also play a role. Pets are now treated for arthritis, cancer, heart disease, diabetes, allergies, dementia, and even obesity – sometimes with the same drugs as humans. The unabsorbed quantities get passed through.

Thus, many of these drugs enter the environment through human and animal waste. Moreover, when cleaning our medicine box, what do we do with the expired medicines or the medicines that we no longer need? We either flush them down into the sewer or toss them into the dustbin. *Gone and Forgotten!*

Forgotten yes, but not really gone as these ultimately end up in the domestic wastewater or garbage of the city. Although this is a very convenient action, it results in the contamination of the water resources and thereby our drinking water supplies. Other sources include indiscriminate disposal practices by pharmaceutical industries, hospitals and medical facilities.

It is well known that most of the cities do not have Sewage Treatment Plants and even if present, the water treatment facilities are not designed for the removal of the pharmaceutical residues. Moreover, much of the contamination of water is from non-point sources, like surface runoffs, seepage through soils, etc the control of which is not being practiced.

Treated/untreated wastewater and surface runoffs carrying the excreted pharmaceuticals reach the rivers, reservoirs and other water bodies from where the water goes back to the water supply systems and is brought back to the consumers. Some drugs, including widely used cholesterol fighters, tranquilisers, etc. resist drinking water and waste water treatment processes.

As of today, there are no Sewage Treatment or Drinking Water Treatment

The fact remains that pharmaceuticals are meant to be prescribed to people who need them and not to be delivered to everyone in their drinking water.

plants specifically designed to remove pharmaceuticals in drinking water. Evidence has also shown that chlorine dosing to disinfect water can actually make some compounds more harmful.

The concentration of most of these chemicals measured in surface waters and ground water can be very low, in parts per trillion and therefore far below the recommended prescription dosage. However, evidence is mounting that these pharmaceuticals are entering the food chain and reaching the humans. At this time little is known about the effects of pharmaceuticals in drinking water and their presence does not necessarily mean it is harmful to humans. The fact remains that pharmaceuticals are meant to be prescribed to people who need them and not to be delivered to everyone in their drinking water.

Research has shown that small amounts of medications have had adverse effects on human cells and contaminated waters have damaged wildlife, especially fish. There's growing concern in the scientific community, meanwhile, that certain drugs or combinations of drugs may harm humans over decades because water, unlike most specific foods, is consumed in sizable amounts every day. No one knows what long term effects can happen due to years of exposure to these drugs. However, some experts say medications may pose a unique danger because, unlike most pollutants, they were crafted to act on the human body.

"These are chemicals that are designed to have very specific effects at very low concentrations. That's what pharmaceuticals do. So when they get out to the environment, it should not be a shock to people that they have effects," says zoologist John Sumpter at Brunel University in London, who has studied trace hormones, heart medicine and other drugs.

Studies indicate that these chemicals are already harming reptiles, fish and aquatic fauna. Impact on human health including reproductive function is among the concerns that warrant increased attention to the presence of these chemicals in water supplies. As per WHO, even though human risk assessments have shown that low concentrations of pharmaceuticals in drinking water have negligible health risks, long term exposures have not been evaluated especially in debilitated or immune suppressed populations like infants, old people, etc.

Antibiotics in the environment raise a potential concern because disease-causing bacteria exposed to low levels of antibiotics over extended periods of time may lead to resistant strains that cannot be treated easily. Scientists are also concerned that exposure to a combination of these chemicals and pharmaceuticals may disrupt human hormone systems, may cause lower sperm counts, increased rate of cancers and increased incidence of hyperactivity.

Cattle, for example, are given ear implants that provide a slow release of trenbolone, an anabolic steroid used by some bodybuilders, which causes cattle to bulk up. But not all the trenbolone circulating in a steer is metabolized. A German study showed 10 percent of the steroid passed right through the animals.

Ask the pharmaceutical industry whether the contamination of water supplies is a problem, and officials will tell you no. "Based on what we now know, I would say we find there's little or no risk from pharmaceuticals in the environment to human health," said microbiologist Thomas White, a consultant for the Pharmaceutical Research and Manufacturers of America.

But at a conference last summer, Mary Buzby, director of environmental technology for drug maker Merck & Co. Inc., said: "There's no doubt about it, pharmaceuticals are being detected in the environment and there is genuine concern that these compounds, in the small concentrations that they're at, could be causing impacts to human health or to aquatic organisms."

Water sampled downstream of a Nebraska feedlot had steroid levels four times as high as the water taken upstream. Male fathead minnows living in that downstream area had low testosterone levels and small heads.

Other veterinary drugs also play a role. Pets are now treated for arthritis, cancer, heart disease, diabetes, allergies, dementia, and even obesity – sometimes with the same drugs as humans.

There are no standards or monitoring requirements for pharmaceuticals in drinking water or treated wastewater. It is proposed to address this issue in the plan of work of the next rolling revision of WHO guidelines for Drinking Water Quality.

Prevention is always the best strategy for reducing contamination. Individuals can minimize overuse and misuse of pharmaceuticals and return unused medicines to chemists who in turn may send them to the respective manufacturer for proper disposal. Mass awareness may be created for not using the toilet or city sewer system as a disposal method for unused medicines or other chemical waste. The pharmaceutical industries also need to produce more environment friendly chemicals and increase point of use treatment.

Less than 2% of all water consumed is ingested by humans. However, with increase in population the total requirement of water for drinking purposes is constantly increasing. In areas where groundwater quality is not affected, disinfection may be sufficient, but where ground water is unfit or where surface water bodies are used for drinking water supplies, elaborate purification systems are required.

Point-of-use systems are most cost effective and environmentally friendly. Certified home filtering systems and water treatment systems can act as a final stage of contaminant removal and can further purify water for drinking. It is generally cost prohibitive for utilities to use systems such as nano-filteration, long contact activated carbon and ROs. Appropriate reverse osmosis units at the end point could be one solution.

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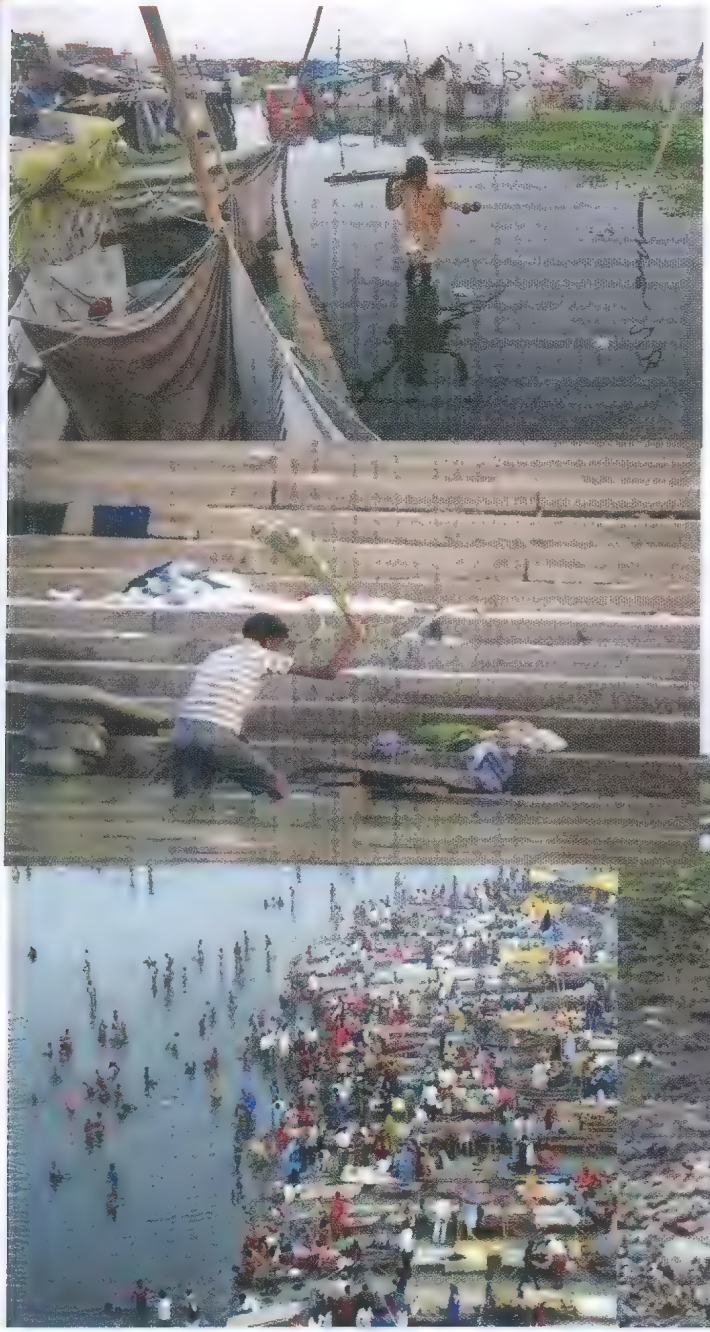
YAMUNA

Lifeline of the Country in Danger

The water of the river Yamuna is not only unfit for drinking but also for bathing and washing clothes. Despite huge amounts of money having being spent on cleaning up the river little has changed. There is a need to adopt a sincere and focused approach, not just in the case of the Yamuna but also rivers throughout the country.

K.P. AGRAWAL



THE Yamuna after originating from Yamunotri in Uttarakashi district of Uttarakhand flows 1,370 km through many towns and cities downstream and merges with the Ganga in Prayag. And on its way it gathers huge amounts of muck.

The stretch between Delhi (Wazirabad) and Etawah is highly polluted due to effluents from Faridabad, Gurgaon, Karnal, Panipat, Sonepat, Yamunanagar, Ghaziabad, Muzaffarnagar, Noida, Saharanpur, Mathura, Vrindaban, Agra and Etawah. Its water is full of carcinogens, effluents, sewage and domestic waste and is not only unfit for drinking but even unfit for bathing and washing clothes.

The condition of the flow in the Yamuna as well as its water quality is alarming. The Yamuna basin is falling at the annual rate

of 0.15 m per year. The flow in the summers is reduced to 5 cubic meters per second, which is much below the required flow of at least 58 cubic meters per second needed to dilute wastes drained in the river.

Delhi's history is intrinsically linked to the Yamuna. It enters Delhi from Wazirabad barrage and passes through the Okhla barrage. In its 22 km course in Delhi, the river receives a huge amount of sewage, domestic waste and industrial effluents that transform the river into a sluggish sewage drain with stinking filth, plastic and toxic chemicals.

Even though Delhi constitutes only 2% of the catchment area of the Yamuna, it is responsible for about 80% of its pollution load. The Yamuna from Wazirabad to Okhla has become one of the most threatened riverine ecosystems of the world. The state of the Yamuna mainly covering its 22 km course in Delhi is pathetic.

Yamuna is not fit even for bathing

Yamuna Pollution

The river loses its colour and character during its 22 km course in Delhi. The Biochemical Oxygen Demand (BOD) level has gone up to 35 miligram/litre as against 3 miligram/litre and Dissolved Oxygen Level (DO) has come down to an alarming zero as against a minimum of 5 mg/litre. The total coliform count is 2.4 crore/100 ml as against 5,000/100 ml, the prescribed norms.

No aquatic life can survive under these conditions. Water is not fit even for irrigation particularly for vegetable crops that are eaten raw. In fact, the river has turned into no more than a stinky drain in spite of spending more than Rs. 1,400 crore on cleaning up the 22 km of the river course through Delhi.

The pollution in the river is mainly due to untreated sewage, dumping of garbage, industrial effluents, domestic waste, animal carcasses, puja material, encroachments and construction of un-authorized colonies on the river banks and along the drains. According to a report of the Central Pollution Control Board, Delhi alone spills about 4,300 million litres (MLD) of sewage into the 22 km stretch of the river every day as against treatment capacity of 2,330 million litres per day. Twenty-two drains keep unloading the city's sewage in to the river. The major drains are: Burari drain, Najafgarh drain, Civil Mill drain, Power House drain, Dr Sen's Nursing Home drain, Barapulla drain and Shahadra drain.

There are more than 60,000 slum dwellings inhabiting about 3.5 lakh people on the river banks and along the drains. These slums contribute significantly to the Yamuna's pollution by discharging all types of wastes directly into the river. Other than that, the majority of people living in the unauthorized colonies and jhuggi-jhopari clusters dump solid waste into the open ultimately blocking the drains. Use of flyash on the riverbed also pollutes the water.

During festive season like Dushehra, Durga Puja and Diwali, immersion of puja material and its ill effects on the river water have been highlighted time and again for the past few years. According to an estimate, it is roughly 36 tonnes of paints, 18 tonnes of oil and polish and equal amount of flowers, leaves, coconut husks, straw and bamboo.

Massive construction work in recent years on river banks has added to the problem of pollution and scanty river flow. The width of the river has narrowed down from 3.5 km to less than half kilometer. Construction and throwing of solid wastes has adversely affected the river flow. The shortage of sewage treatment, insufficient sanitation facilities, lack of awareness and civic sense towards sanitation add to the problem.

Cleaning the Yamuna

Steps taken so far have not yielded any concrete results. The work on cleaning the Yamuna river has been going on for many years. A string of elaborate action plans have been announced by different agencies. More than Rs. 1,500 crore spent by different

Froth due to industrial pollution in Yamuna

Sewage treatment plant

agencies has not yielded any concrete results. In fact, the Yamuna has become more polluted over the years.

A three-stage plan to clean the Yamuna was developed by the Delhi Development Authority (DDA) about three decades back. The plan included: i) installing a sewage treatment plant on each drain before falling in the river, ii) constructing a canal parallel to the river, connecting all sewer drains in it and diverting the water after cleaning to Haryana for irrigation purpose and iii) channelizing the river and concretizing the river bank after a uniform width and removing silt to allow rain water to retain in Delhi. The plan was not executed.

The Yamuna Action Plan which had to improve the quality of water along the 22 km stretch of Delhi and adjoining areas of Haryana and UP did not lead to any significant improvements in spite of Rs. 1,500 crore being spent under the Yamuna Action Plan I & II. Out of 30 sewage treatment plants, hardly 10 are fully functional. Only 15% of the 33,000 MLD sewage is treated, the remaining 85% goes into the river.

An ambitious Rs. 2,000 crore project was announced in 2007 by the Delhi Jal Board (DJB) to restore the river on the same lines as the Thames. An agreement was signed between DJB and Engineers India Ltd (EIL) to lay interceptor lines along three major drains – the Najafgarh drain, Supplementary drain and the Shahadra drain to ensure that untreated sewage water did not flow into the river. With this interception approach, it was expected that by 2010, the capital could have a clean Yamuna river. A decision was taken to set up 18 sewage treatment plants (STPs) at the mouth of each drain joining the river. Interestingly, the DJB had conceded in an RTI reply that the treated water is not even fit for bathing. Therefore the main purpose of interceptor Sewer Project seems to have been defeated. Spending such a huge amount without turning treated water even fit for bathing is simply a waste.

Very recently, DJB initiated another plan to save the river. Six NGOs were roped in. A public outreach programme, "Aao Jamuna Mein Jaan Daalein" under the Yamuna Action Plan (YAP)–II, especially involving the children was initiated.

The Noida Authority also initiated construction of four sewer treatment plants on the Yamuna and Hindon banks to make Noida a zero-discharge city by 2015. The plan is to use the water treatment plants for irrigation and construction work and use the silt after drying as manure.

Even court interventions to clean up the Yamuna have failed. The Supreme Court as early as in 2000 directed the Environment and Forest Ministry for fixing 2005 as the deadline to clean the Yamuna. The court also directed the Ministry to file an affidavit detailing the steps the authorities had taken to keep the river pollution free. The Delhi High Court in 2008 appointed the Yamuna Panel to assess the progress of projects related to Common Wealth Games. The panel strongly opposed construction of any concrete structure on the river bed.

According to section 24 of the Water (Prevention of Pollution) Act, which was enacted in 1974, discharge of dirty water into the river is banned. However, the discharge continues to pour in with utter disregard to the Act. Unstable and frequent changes in plans are the major reasons of failure.

Reasons of Failures

Several reasons have been given by the agencies that have taken measures so far to clean the river. Some of these are: i) sewage treatment is very expensive and costs Rs. 50 lakh to treat a million litres per day, ii) shortage of sewage treatment plants of which many remain non-functional, iii) more than 60,000 slums on Yamuna bank are difficult to relocate due to non availability of land and iv) lack of expertise available in the country.

But the moot point is that it is because of the involvement of half-a-dozen or so agencies in cleaning up the Yamuna that there has been no headway so far. One agency puts the blame on the other. Absence of coordination between different agencies adds to the confusion. Each agency has its own agenda and priorities. For instance, for the Department of Environment the priority is to afforest one-kilometer wide area along the river's course, while DDA would like to develop parks and recreational areas, which would require many concrete structures.

Cleaning of the Yamuna seems to be no body's baby. But when it comes to fund allotment, everyone wants to stand first in the queue.

Future Action Plan

The river is putrefied and almost dead from Wazirabad onwards. Reviving the river to its original stage is a difficult task. About 50 years ago, the Hudson River in New York was as bad as the Yamuna. But with sustained efforts and community participation, the river reversed back to its original state. Why then can the same not be replicated with the Yamuna? The need is for a holistic approach and a time-bound action plan so that Yamuna could be brought back to its ancient glory.

A river is not simply a flow of water. It includes riverbeds, local ecology and the banks. All these points should be taken in consideration and future strategies should be developed accordingly.

Yamuna's water is full of carcinogens, effluents, sewage and domestic waste and is not only unfit for drinking but even unfit for bathing and washing clothes.

The riverbed area in Delhi (from Wazirabad to Okhla) is 97 sq km. The entire riverbed area has coarse grain sand up to a depth of 40 meters, which is the key to the riverbed's water recharge. With massive concrete work, much of the riverbed has already been lost. Due to construction structures and coming up of numerous bridges, the flood plain has been narrowed down and the river has substantially lost its carrying capacity due to heavy silting.

The present width of the river has to be maintained at any cost. No further construction and encroachment should be allowed. All unauthorized inhabitants on the riverbed should be removed and settled elsewhere.

Large-scale extraction of river water at the upstream of Delhi for drinking and irrigation purposes has led to negligible flow in the river after Wazirabad. Measures should be taken for improving river flow. Entry of drainage waste into the river should be stopped. Regular dredging and desilting improves carrying capacity and river flow.

About 50% of the water is wasted in Delhi due to leakage. This should be prevented. Walls should be constructed on both sides of the river to stop narrowing down of the river bed width. An effort should be made to de link sewage from storm -water drains. Laying of sewer lines throughout Delhi should be a priority.

"Too many cooks spoil the broth" is applicable to the efforts of multiple agencies engaged in cleaning Yamuna. A single authority to override the problem of multiple agencies should be appointed. The authority must be empowered to issue directions to any department or agency and its decision should be binding on all the agencies.

A Nodal Authority that works efficiently, keeps corruption at bay and coordinates well with other agencies should be constituted. It should be given authority so that the decision making process becomes easy for smooth discharge of work. Agencies responsible for inordinate delay should be penalized. Private players should also be roped in for the project. All the industries should be pulled up for discharging effluents into the river. Accountability and transparency should be maintained at all costs.

A blueprint to contain pollution in the city should be developed. Sewage (treated or untreated) should not be allowed to fall in the river. The treated sewage should be diverted through canal for agricultural work or put back into the ground. Only treated water should be flown into the river. Putting back treated water into the ground would recharge the ground water level as well. The approach would result in zero flow of sewage into the river. Dense afforestation, particularly of trees like eucalyptus that have heavy rate of transpiration, should be avoided.

'Yamuna Yatra' should be organized to spread awareness about pollution and the need to save the river. Various competitions and rallies should be organized on Yamuna rejuvenation.

In fact, a day should be declared as 'Save River Day' throughout the country. Important rivers covering mainly the rivers' passing through cities should be the main focus on this day. School children should be involved in creating awareness. Riverbanks should be beautified so that people coming there understand the importance of rivers. The public should be made aware during the festive season about the adverse effects of idol immersion and other puja material. Traditional clay and water-soluble and non-toxic natural dyes should be used in making the idols.

Last but not the least, strong political will, commitment, serious and concerted efforts and focused approach are mantras for the success of any river cleaning programme.

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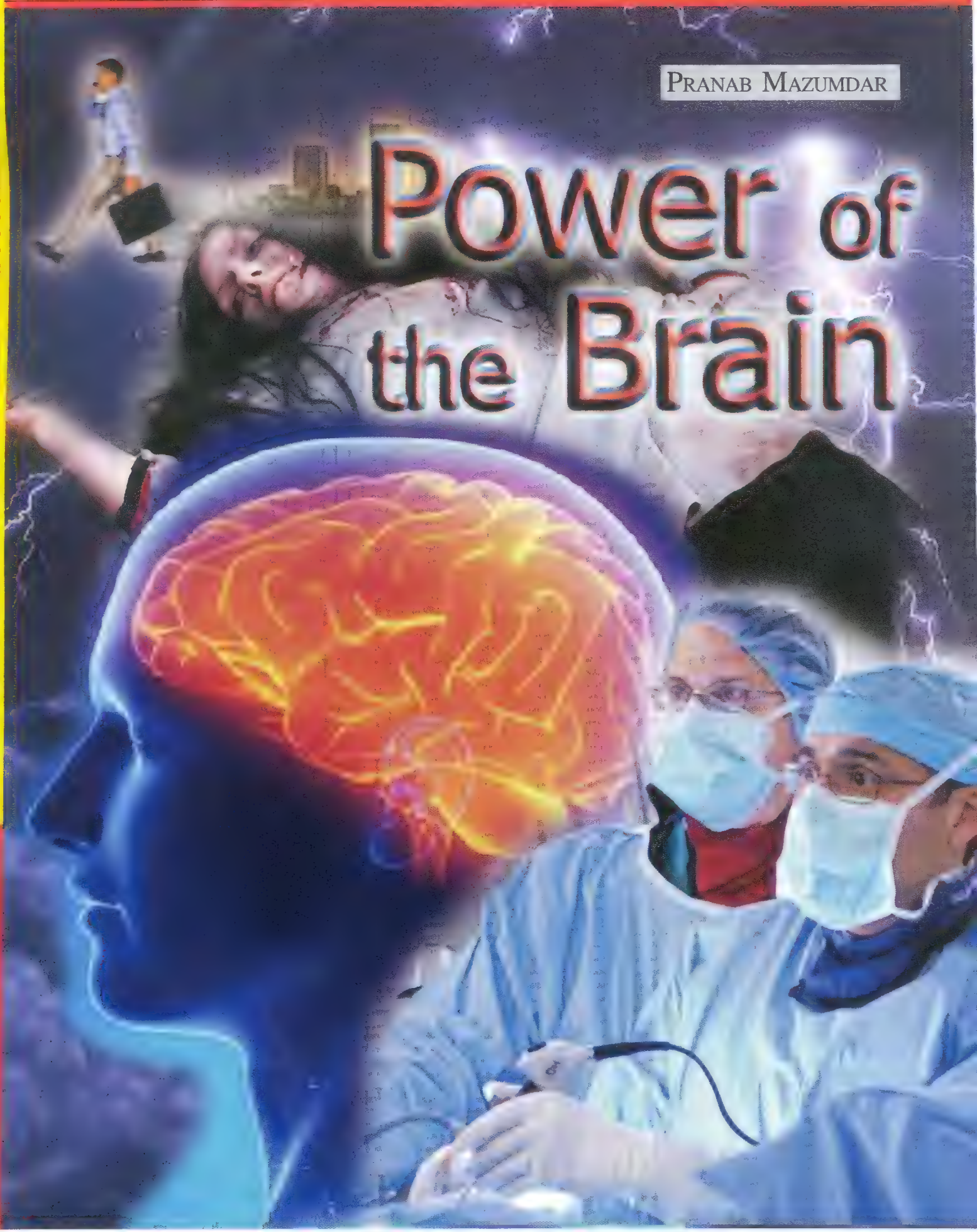
PRANAB MAZUMDAR

Power of the Brain



He.....never realized Sulochana would be so frightened. In her hurry to get away, she fell from the chair and banged her head against the steel frame. Then she crushed her head again against the hard floor. Sulochana was always very delicate....

IT had been the neurologist's fervent desire to acquire a human brain so that he could carry on his research that primarily focused on telepathy. But, donors were hard to come by and, after years of waiting, this magnificent organ had arrived only yesterday. The brain had belonged to a 60-year old spinster who had pledged her body for medical research.

The good doctor thanked the woman a million times for her magnanimous gesture little knowing that she had met, not a natural death, but a violent one. She had slipped and fallen off a high chair. The fall had severely injured her head and she had died instantaneously. The benefactor of medical research had communicated to the local hospital much earlier about her desire to donate her body after death and her only surviving brother had assented to the same after the accident.

Dr Shrivastava knew nothing of all this. He was a man of science and that was his chief mission in life.

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Thirty kilometres away, in a small town called Bhairavnagar, a man slept soundly although it was 10 am in the morning and any other human being should have been up and about at this hour.

But, Shishir Mishra, oblivious to worldly concerns, slept soundly. It had been a long time since he had slept so well. An avid race goer, Shishir had squandered all his money at the racecourse. He had borrowed heavily and lost all of it. His creditors had hounded him for months together, threatened him and even beaten him up on several occasions. They had taken away his sleep.

Last month, however, Shishir had come in for some unexpected wealth. He had paid up all his creditors and, at last, got back his sleep.

Dr Shrivastava was a bachelor. Had he been married, his marital life would have been a disaster. The good doctor had the habit of getting up in the middle of the night and tinker around in his laboratory till early morning. No wife would have put up with such eccentric behaviour.

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After the brain arrived, Dr Shrivastava had lost all sleep. He was so excited that had it been within his powers, he would have spent 24 hours of the day in his laboratory. But that was not to be. The doctor had to attend to his patients and it was only late in the night that Dr Shrivastava could sneak into his lab and indulge in his passion.

He got up now and unmindful of the fact that he was only half dressed, hurried towards his lab. Once inside, he went straight to his favourite jar.

The human brain is the most fascinating organ the walnut shaped organ, weighing only around 1200 grams, controlled every aspect of the human life ... the thought processes and the physical movements. The body was a mere casing, the real individual was the brain. The doctor marveled at the enormous power of the brain that could solve the most complex problems, recall incidents that had occurred long, long ago, and unleash the creativity in humans.

The doctor connected electrodes to the brain and set up his apparatus. The ammeter before him showed a slight deflection, signifying the electric impulses that the brain in the jar was yet capable of sending. The doctor was agog. He needed to amplify the signals that could be digitized and, then, converted into sound. The doctor would then know what the person, to whom the brain belonged, was thinking immediately before death. The doctor decided to halt his experiments for the day, rather for the night.

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Thirty kilometers away, Shishir stirred in his sleep. Someone, it seemed, had called out his name. But that was probably his imagination and he was soon snoring peacefully again.

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The next night, Dr Shrivastava had the apparatus ready to amplify the signals. He connected the eectrodes to the brain. There was a greater deflection on the ammeter this time. The doctor was excited. Now, he thought, the only thing that remained to be done was to convert the electric signals into sound.

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Thirty kilometers away, Shishir got up from his sleep. He was perspiring although it was a cold December night. The sound was distinct ... It was the voice of his sister and she was accusing him. "It is you who have killed me," the voice seemed to say.

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The doctor removed the apparatus. His experiment had lasted only for 15 minutes this time. But, he could do no more tonight unless he had the equipment necessary to convert the electric signals into sound. Although reluctant, the doctor could do nothing but wait for the morrow when he would be able to

acquire that equipment. At this hour, there would be no one awake to cater to his requests.

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The voice died down and Shishir went back to sleep.

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To Dr Shrivastava's chagrin, the equipment he needed was not available in his city. He would have to order the same from Mumbai, which was 200 kilometres away. It would take at least four days for the shipment to arrive. The good doctor resigned himself to his fate but carried on with his experiment in an effort to amplify the signals further and further.

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Meanwhile, Shishir's torment increased. Every night he would be rudely awakened from his sound sleep by his sister's voice that grew shriller and shriller in her accusations. The duration of the torment also increased. On the first night that he had been so awakened, the voice had died away after only a few minutes and he could go back to sleep. But now, the voice pestered him for hours together. Once it had died down, he could not go back to sleep but sat looking haggard on his bed, drenched in perspiration.

Shishir was in bad shape. Lack of sleep had reduced him to a deranged man. He had lost his appetite and was transformed into a derelict.

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At long last, the equipment arrived. Dr Shrivastava could not wait to rush to his laboratory. The fruition of his years of research was in sight. It was a long agonising wait, but dusk did fall and after finishing his chores, the doctor entered the laboratory past midnight.

He set up the apparatus and arranged the powerful speakers. Tonight, thought the doctor, he would hear what no one had heard before. He would hear a dead person speak.

But, something was wrong. Probably, his research had not been so thorough after all. There was much greater amplification of the electric signals from the brain but the speakers were mute ... not a sound came from them. Dr Shrivastava was dejected. He worked hard to get the speakers function but even as broad daylight pierced into the room from one of the windows, the speakers uttered not a mutter.

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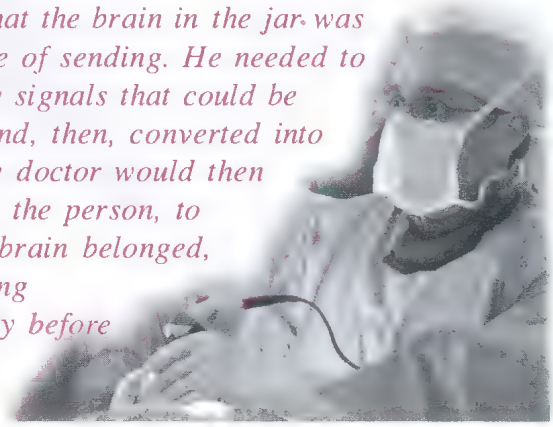
This particular night had been really bad for Shishir. "You have killed me, yes it is you who have killed me," his sister's voice harangued him ceaselessly. Shishir could take it no further. He rushed out of his bedroom in his sleeping gown and headed straight for the nearest police station.

Inspector Sharma was a happy man. He had no ambitions and even if he had any, this small town of Bhairavnagar would not have assisted him in his endeavours in any manner. Leave alone murders, Bhairavnagar had not even reported a theft for the past eight months. And here was a man who had disturbed his sleep at 7 am to tell him that he had committed a murder. The inspector was aware that Shishir's sister had died one month back after she suffered a fatal fall from a high ancestral chair.

The doctor connected electrodes to the brain and set up his apparatus. The ammeter before him showed a slight deflection, signifying the electric impulses that the brain in the jar was yet capable of sending. He needed to amplify the signals that could be digitized and, then, converted into sound. The doctor would then know what the person, to whom the brain belonged, was thinking immediately before death.



"I did not wish to kill her. I just wanted to frighten her," Shishir was telling the inspector. "She knew I was heavily indebted and my creditors were troubling me. Yet, she would not lend me any money although she had piles of it stacked away in her cupboard. I just wanted to scare her as an act of revenge," he was saying.

"She suffered from ophidiophobia – she was just scared of snakes," he went on. "The sight of the slimy creatures even on television terrified her. She liked to sit on this high ancestral chair and gaze out of the window."

"Sulochana was so small that I had, on several occasions, warned her against climbing on to this chair as she could fall and hurt herself. But she would not listen to me," Shishir was telling inspector Sharma. He told the police officer how he had acquired a rubber snake and flung it into the room through the window.

"It was only to scare her. I never realized Sulochana would be so frightened. In her hurry to get away, she fell from the chair and banged her head against the steel frame. Then she crushed her head again against the hard floor. Sulochana was always very delicate." She had seen him commit the act before dying. He had removed the rubber snake immediately and had also taken away the cash from the cupboard to pay off his creditors. A dead woman has no use for money, he had thought.

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Dr Shrivastava was crushed. His years of research had come to nought. The good doctor removed the jar and stacked it away with other specimens in his laboratory. There was no such thing as thought waves travelling in the air ... it was just his weird theory that had been proved wrong. He dismantled the apparatus and vowed never to touch it again.

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Thirty kilometers away, Shishir lay on the bare hard floor of the jail cell and yet he was in deep slumber. Hypnos, the god of sleep, had never been more kind on him before.

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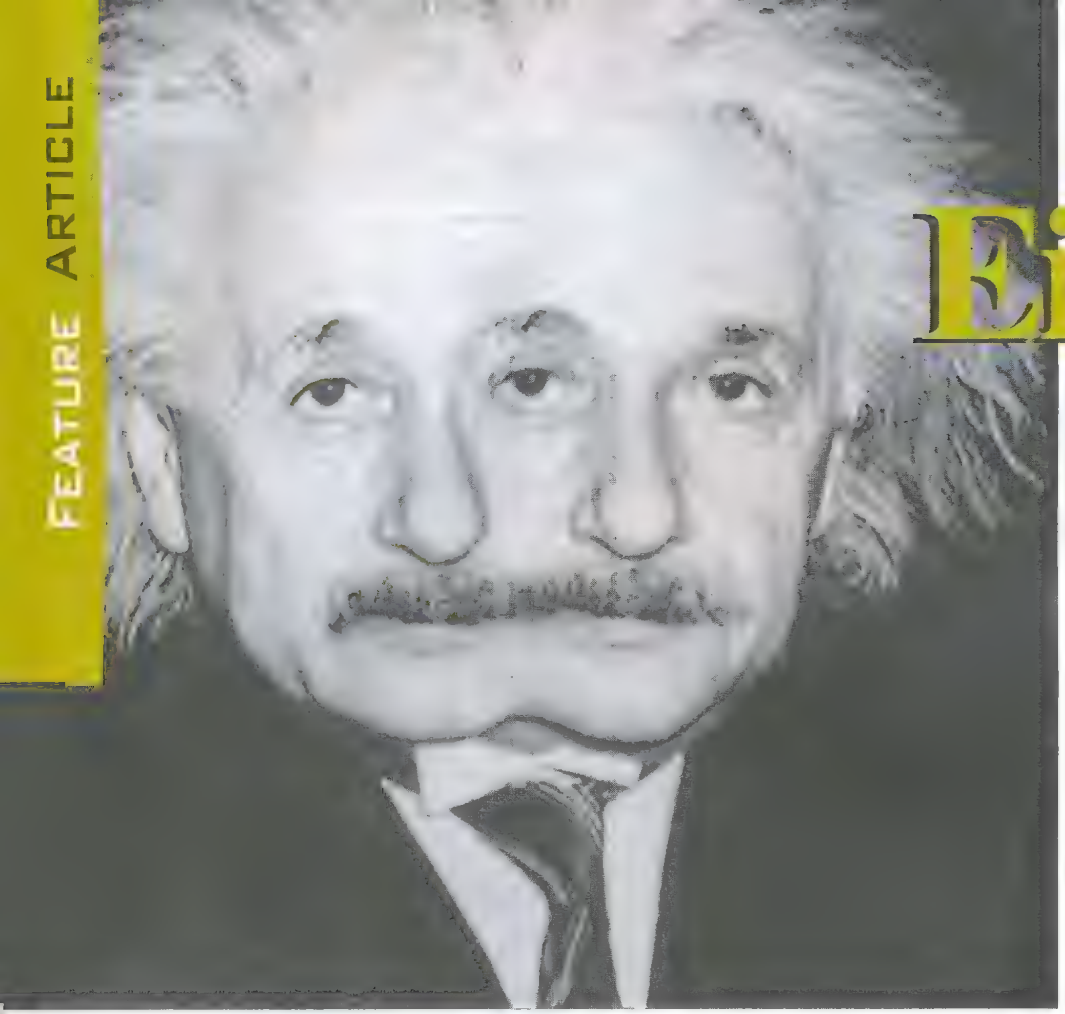


PARESH R. VAIDYA

Einstein: Consistent Scientist & Inconsistent Man

Did Einstein's commitments come from the brain rather than the heart? Here's a view.

ALBERT Einstein is recognized as the brightest scientist of the 20th Century. His simple theory of photo-electric effect broke ground for the later development of quantum physics, but he is more known for his theory of relativity. This, particularly the general theory of relativity, is more abstract and has nearly no direct consequence to everyday life and yet it got him unprecedented fame is a surprise. It probably has to do with his unusual personal looks and simplicity. Apart from science he got involved in socio political issues after 1915 and that may be another reason for his popularity.

Einstein was born a German and was concerned about the German pride. Germany got defeated in the First World War and had to sign a humbling treaty. Einstein traveled through Europe for the cause of unity and explaining the German case. He was also a member of the committee of International Co-operation of the League of Nations along with Madam Curie. (League of Nations was formed after the First World War just as the United Nations was formed after the Second World War.)

Later, during 1928 to 1931, he was a member of the War Resistors' International, the organization fighting the compulsory military enrolment of the youth; it exists even today and works for world peace. These and some other facts of his life are less known. However, when some of the events in his life came out in the open, his fans had a minor problem reconciling with the fact that he was not a man with a consistent mind. His actions did not match with the liberal image that he had. These unknown aspects of his temper and actions came out on two different occasions when his personal letters were brought out in the open.

Sometime in 1986 a bank locker in San Francisco was opened after the death of its owner Hans Albert, Einstein's son. He had done his best to guard the unpleasant truth for 40 long years. There were over 400 letters relating to Einstein's personal life. But the most interesting and informing were 41 letters written by him to his wife Mileva and 10 by her to him which revolved around their love affair.

For the first time it came to be known that Einstein and Mileva Maric had a daughter before they married. This information was published for the first time in a biography of Mileva in the German language. These letters could be read in English only in 1992 in a Princeton University Press publication entitled *'Albert Einstein-Mileva Maric, the love letters'*. In 1996, they were on display in Jerusalem and were on auction in USA.

Einstein with son Hans Albert

COMMANDMENTS FROM A SCIENTIST

Einstein once defined marriage as 'an invention by an unimaginative pig'. Look at what he desired from his wife, about a decade after their marriage.

"A. you will see to it that

1. My clothes and linen are kept in order
2. I am served three regular meals a day in my room
3. My bedroom and study are always kept in good order and my desk is never touched by anyone other than me.

B. You will renounce all personal relations with me, except those that are required to keep up social appearances. In particular you will not request that

1. I sit with you at home
2. I go out with you or travel with you

C. You will promise explicitly to observe the following points

1. You will expect no affection from me and not reproach me for this
2. You must answer at once when I speak to you
3. You must leave my bedroom or study at once without protesting when I ask you to go
4. You will promise not to denigrate me in the eyes of my children by words or by deeds.

No surprise that they separated within months of this letter, though formal divorce took years. Mileva took her two sons away to Zurich where they lived earlier. Einstein continued at Berlin, in his new job. But the wordings of the letter show that she must have been a lady with pestering and arguing habits: something in which he could not afford to waste time, as he was deeply into developing a 'General theory of relativity' in those days, the biggest of his contributions.

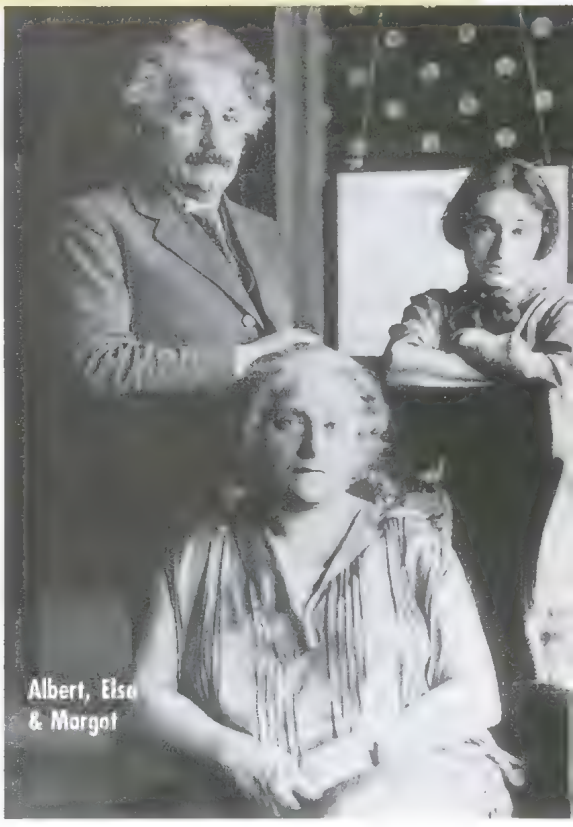
Had Einstein been alive or had he been some political figure rather than a scientist, this piece of information could have kicked off a lot of dust. Probably it would have been scandalized. But mercifully the public adoration for him left the matter underplayed. Even during the spurt of extra attention due to the auction of his letters and related litigations, the media did not harp on the topic of his pre-wed daughter.

Albert and Mileva first met in the year 1896 when both were studying at the Federal Institute of Technology in Zurich, Switzerland. Mileva changed her course from medi-cine to Physics and came to Einstein's class. She was a Serbian girl, four years elder to Einstein and had come to study in Zurich just as Einstein had come from Germany.

Einstein's Wedding

The first letter indicating closer connection between the two is written by Mileva in 1897, informing Albert that she has already talked to her father about him and he should visit Germany to meet him. The response to this is not known as the first of Einstein's letters is in February 1898. Though he addressed her as 'Respected Miss' in this letter, in later letters he gradually grew informal and then romantic. 'Respected Miss' became 'Dear Miss Maric' and thereafter 'Little Cat' and further to 'Dear Little Doll'! Mileva began with 'Lieber Herr E'" (Dear Mr. E) and ended some later letters with 'thousand little kisses from your D'.

But Einstein could not convince his mother for the marriage. While she made a big hullabaloo, his father felt that marriage should happen only when the boy settled down. He was probably right as Einstein was only 21 then. But the children had already sunk deep into the sea of love. He writes like anyone else, "when I do not have you I feel as if I do not quite exist". The euphoria ultimately culminated in the birth of a girl in January 1902.



Albert, Elsa & Margot

They named her Lieserl. A year later on 6 January 1903 they got married. However, the daughter did not join the wedlock. The last Lieserl is mentioned is in the letter from Einstein to Mileva when she was in her parent's home, three months

EXCERPTS FROM THE HISTORIC LETTER

Albert Einstein
Old Grove Road
Nassau Point
Peconic, Long Island
August 2, 1939

F.D. Roosevelt
President of the United States
White House, Washington D.C.

Sir:

Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element Uranium may be turned into a new and important source of energy in the immediate future. ... I believe therefore to bring to your attention the following facts and recommendations.

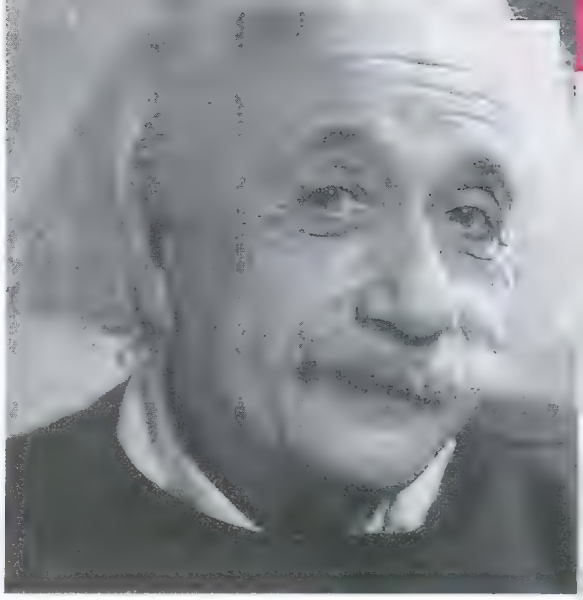
... it may become possible to set up nuclear chain reactions in a large mass of uranium by which vast amount of power and large quantities of new radium like element would be generated.

This new phenomenon would also lead to the construction of bombs, and it is conceivable – though much less certain – that extremely powerful **bombs of a new type** may be constructed. A single bomb of this type might very well destroy the whole port together with some territory. However such bombs may very well prove to be too heavy for transportation by air."

(He then requests urgent research work to start and procurement of uranium ore from Canada, Czechoslovakia or Belgian Congo.)

...I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Wiszsacker, is attached to the Kaiser Wilhelm Institut in Berlin, where some of the American work on Uranium is being repeated.

Yours Very truly,
A. Einstein



after the marriage. Einstein was worried that the little girl had a bout of scarlet fever. The biographers have failed to locate the girl or any hint about her whereabouts after this.

This part of Einstein's life is embarrassing to those who loved the scientist as a soft spoken and dignified person involved in liberal human rights activities. Many reacted negatively because they are measuring him by the latter day image of his personality as an intellectual. This public perception of him developed after 1921 i.e. the post Nobel Prize period.

However, the Einstein that slipped was in his late teens and early twenties, agreeably the vulnerable period. Yet it should be said to his credit that in spite of strong currents of passion and sentiments, he managed to get through his studies well and also began to think about the theory of relativity at that early age.

His work on special theory of relativity published in 1905 was the work of an extremely innovative mind and at the same time demonstrated that the author had deep understanding of the physics and mathematics available till that day. There were two more important publications and the world celebrated the year 2005 as the centenary of that 'Miraculous Year'.

Having absolved the scientist of his teenage bouts, how do we rationalize the fissured marital life that followed the ecstatic marriage? Einstein separated from Mileva in 1914 and divorced her formally in 1919. The papers auc-tioned in 1996 contained a sheet of handwritten draft showing him as a dominant husband laying down a code of conduct for Mileva in and outside the house! It says she must keep his linen and clothes in order and serve him three meals a day. She must not expect to go out with him socializing and many other such things.

No one knows whether this was a piece of a practical joke or a sign of things prevailing in that household. But the period of the letter, 1914, indi-cates it to be a genuine piece. Mileva and two sons had left Berlin and moved to Zurich in that year. It is per-plexing to figure out the reasons rocking their mar-riage. Mileva was not like Xanthippe (Socrates' wife) who is known to be shrewish. She on the contrary was intelligent and simple by nature. She had a minor limp, which was there since their college days and could not have been a good reason for Einstein to dislike her.

Probably his preoccupation with science could have tempted him to be aloof from family affairs. To achieve unusual success one needs to have an excessively single-minded pursuit which is bound to tell on family life. We know how Gandhiji was harsh on his wife and children because for him every thing was secondary to the country's freedom. Einstein's son Hans Albert indeed indicated this reason for the separation of the couple in an interview over the radio, but elsewhere in a letter to his father he casti-gated him for neglecting the needs of his mother.

But this seems to be only a part of the story. Abraham Pais, a student of Einstein who was also close to him personally, has noted in his biography that Einstein had started leaning towards another lady around this time. More than love, it was affection and intimacy because the lady in question, Elsa Einstein was his cousin. After Mileva left him, Einstein fell ill with jaundice and ulcer sometime in 1917 and Elsa took good care during the illness. They eventually married in 1919 after Mileva was divorced.

The court decreed that the Nobel Prize money, which was just about expected, should go to Mileva and her two sons. But the money could not recover their younger son Eduard from schizophrenia which he presumably developed as a child in a broken family. The Elsa-Einstein union lasted till she died in 1936. But his relationship with Mileva remained cordial as testified by his son and many biographers. However, it is difficult to ignore the gentle hint by Pais that even in the midst of the second marriage Einstein was courting another pretty lady.

The other controversial letter concerns his public life unlike the first one. It was addressed to the American President, and was written in August 1939, much after the Mileva letters, but revealed to people much earlier during the 1950s after the declassification of the World War papers related to the first atom bomb. In fact, there were three letters that he wrote to the President on the same subject. The first one requesting him to begin work on a super bomb, the second a reminder when no progress was seen and the third one requesting him not to drop the bomb on anyone, after its unlimited destructive power became known.

The letters were actually inspired by a scientist named Szilard and Einstein had only lent his signature. The last letter has no significance because it was never read by the President as he died before doing so. But the first letter is remarkable because it was written in 1939, when it was not yet practically established that uranium could sustain a chain reaction. It was proved three years after this letter by Enrico Fermi. Yet Einstein forwarded this letter be-cause, he, like others, thought that Germany might be on the job and should not succeed in making a bomb before USA does. Being a letter from the most respected scientist of the times, it got the due attention, but eventually affected millions in Japan and changed the style of politics on a global scale.

An action of this kind would be considered justified if coming from an ordinary person. For example, one would indeed expect Leo Szilard to initiate such a letter, because he had migrated three times from country to country during the war as he was a Jew. He knew the suffering and also the value of a bomb in German hands. But not Einstein. He was a very active pacifist since the First World War. In fact he exhorted students to follow the path of non-violent resistance to oppose compulsory recruitment.

Once in 1930 he said, "I feel only contempt for those who can take pleasure in marching in rank and file to the strains of a band. Surely such men were given their great brains by mistake, the spinal chord would have amply sufficed." He did not like the idea of nationalism and advo-cated "Supranationalism" and a world-government for a long time. He had said that if the danger of war reduces, national boundaries would soon disappear. Then how do we explain this letter from him?

Einstein was a German Jew and had migrated to America after spending some very trying and embarrassing conditions at home. Right from the days of his getting the Nobel Prize in 1921, the Nazis kept belittling his genius and often insulted him in public. They called the Relativity theory a "Jewish Bluff". Positions he held in physics were against odds.

A page in his personal diary on 17th April 1927 reads, "Strange people these Germans. I am a foul smelling flower for them and yet they keep tucking me in to their buttonholes!" His house was ransacked when he was away. Even non-Jewish German students of his were ridiculed. Heisenberg, a famous German scientist, was called a 'white Jew' and not given his due in the University for a long time.

After Hitler came to power, it was impossible for Einstein to continue to live in Germany and hence he migrated to USA. But this departure from Germany shocked him immensely. He loved that country as his own. He spoke and wrote only in German. All his outstanding scientific contributions were first published in Germany's scientific journals. Even the three celebrated papers of 1905 were in *Annalen der physik*, a German journal. (Even his letter to Roosevelt mentioned earlier, requesting a defence against Germany, was dictated in German and translated later by a scientist called Wigner!)

He was abruptly disillusioned by what he got in return. To this end we can expect him to do anything within his power to prevent- Germany from acquiring the nuclear bomb before the Allied nations had it.

But he was bound by a pledge. Being an active member of the War Resistors

International he had pledged not to lend his service to war for whatever cause it came and he had openly declared so. How do we then take his letter requesting a deadly weapon to end a war? It looked quite intriguing to all who knew him. There were some who said they knew him better and expected that. French littérateur and thinker Romain Rolland was one such person who wrote in his personal diary on a similar occasion, "It is quite clear to me that Einstein, a genius in his scientific field is weak, indeci-sive and inconsistent outside it. I have sensed this more than once."

Now, what Rolland knew, people at large did not. They loved him for his childlike simplicity. They learnt about his support to war against Germany only after the epoch making letter was made public. Japanese pacifist Shinahara disturbed by this *volte face*, wrote to him to declare the letter as a regrettable mistake. He said, "I often wonder what Gandhi would have done if he had been in Ein-stein's place? He would not have acted as you did!" He is right because Gandhi's commitment was from the heart.

That is where lies the answer to the variation between the public image of Einstein and his actions: his commitment, be it for his wife Mileva or for peace came from the brain, and not from the heart. Therefore, he could rationalize a change in his stand. After all he was a scientist!

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Classical and contemporary muscle forms as depicted by Michelangelo's biblical David (left) and actor Arnold Schwarzenegger (right)

Retaining Muscle Strength

PRASANTA K. DASH & RHITU RAI

A new approach could prevent or delay loss of muscle strength and thereby decrease the frequency of broken bones in the elderly or muscular dystrophy in the young.

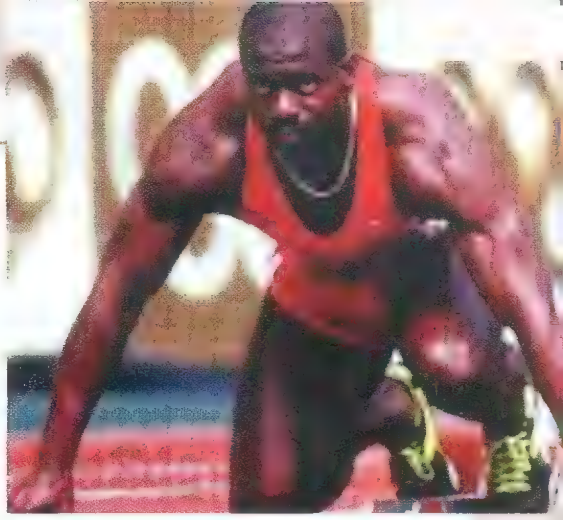
MUSCLES have played a prominent role in the evolution of human beings from primate ancestors and also idealization of the male human form. Even today, Michelangelo's sculpture of David epitomizes a classical picture of excellence of the youthful male human form. The strength and power of David's skeletal muscles shining through the marble leave us with a mental picture of his easy domination over the gigantic Goliath. In modern times, an example of the idealization of a male human form is the bodybuilding champion and actor Arnold Schwarzenegger. Classical and contemporary muscle forms have always testified the importance of muscles in images of male strength and power.

Individually articulated different groups of skeletal muscles much larger than those pictured in the statue of David are acquired by the likes of Schwarzenegger through specialized weight training and a tough regime of exercises. Many times, anabolic steroids (chemical muscle stimulants) are used in combination with weight lifting to increase muscle size and strength. Examples of such compounds include methandrostenolone (Dianabo 1), Boldenone (Equip-gan), Stanazolol (Winstrol V) and Drostanolone (Masteron).

As information about the effects of steroids spread, they began to be increasingly used by professional and amateur athletes although use of many of these compounds is banned by anti-doping organizations. The most noteworthy example is the disqualification of Canadian sprinter Ben Johnson, who won the gold medal in the 100 m sprint event at the Seoul Olympics in 1988. The title and the record were subsequently rescinded as he was disqualified for doping the banned muscle stimulating steroid stanazolol.

Muscles, therefore, are essential to human life in a variety of ways. They are central components of physical strength and speed, attributes that are admired in most human cultures. Mobility of an individual depends on the strength of his muscles; whether one uses them to walk, run, and put his foot on the pedals of bicycles or hands on the brakes. As a basic component of physical vigour they also play a role in human attractiveness. As such, muscle tone is a major contributor to the 'sense of self" developed by each person.

During childhood, physical and sports activities develop and strengthen the muscles while at puberty production of estrogen and testosterone hormones enhance these processes. The muscular development usually peaks between 20



Canadian sprinter Ben Johnson was stripped of his gold medal at the 1988 Seoul Olympics (right)

and 30 years of age. Subsequently, strength and size of muscles declines by one-third between the ages of 30 and 80. Although it is difficult to define the exact number of muscles in humans it is approximated to be 640-850 types. Almost every muscle is part of a pair of identical muscles found on both sides of the body resulting in approximately 400 pairs of muscles.

Muscles move body parts by contracting and then relaxing. They pull bones but on their own cannot push them back to their original position. Thus, they work in pairs of flexors and extensors. First, the flexor contracts to bend a limb at a joint, then the extensor contracts to extend or straighten the limb at the same joint. For example, the biceps muscle in the front of the upper arm is a flexor and the triceps at the back of the upper arm is an extensor.

One of the strongest muscles in the human body is the jaw muscle that is active during mastication, biting, speech, and swallowing. To execute this variety in tasks, they control the position of the mandible precisely by instantaneously changing the forces applied on it. They are able to meet these different requirements because of their complex architecture in combination with a heterogeneous composition of fibres capable of producing a variety of forces at different contraction speeds.

Muscles in isolation do not generate strength and speed. They need to be physically integrated with bones and function harmoniously through their attachments to nerves, tendons and ligaments. They pull on the joints and allow us to move. Even when we sit perfectly still, there are muscles throughout our body that are constantly moving. Muscles enable our heart to beat, chest to rise and fall during breathing, our blood vessels to help regulate the pressure and flow of blood throughout our body. Even when we smile and talk, muscles are helping us to communicate. All these activities accomplished by movements of the muscles are coordinated and controlled by the brain and nervous system.

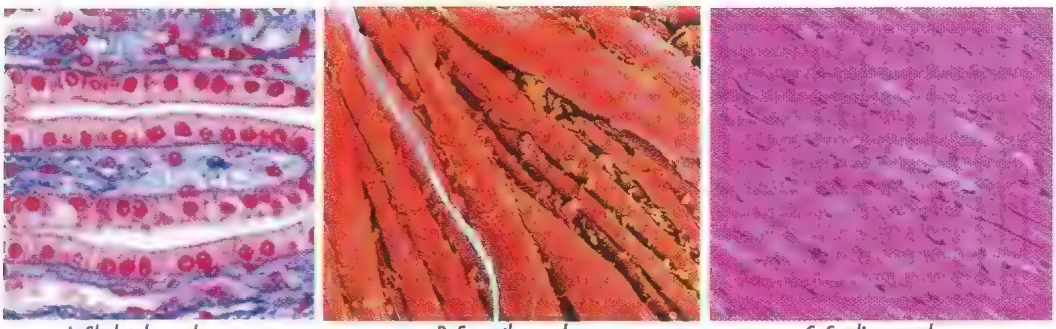
The human body contains three types of muscles such as the skeletal, smooth and cardiac muscles. Only skeletal muscles (40 percent of the body), responsible for shapely thighs and enviable pectorals, are controlled by the brain. These muscles are attached to the bone, mostly in the legs, arms, abdomen, chest, neck, and face. They are called striated muscles because they are made up of fibres that have horizontal stripes. These muscles hold the skeleton together, give the body shape and help it with everyday movements and are known as voluntary muscles because one can control their movement. They contract quickly and powerfully to produce burst of energy but tire very quickly.

The smooth or involuntary muscle is also made of fibres but this type of muscle looks smooth and not striated. Smooth muscles are controlled by the nervous system automatically and are also called involuntary muscles. Examples of smooth muscles are the walls of the stomach and intestines, which help break up food and move it through the digestive system. They are also found in the walls of blood vessels, where they function to squeeze out blood flowing through the vessels to maintain blood pressure. They take a longer time to contract than skeletal muscles but can stay contracted for a long time and don't tire easily.

Cardiac muscle is a unique type, found only in the heart. The walls of the heart's chambers are composed almost entirely of these muscle fibres. These are also involuntary type of muscle. These are rhythmic, powerful in contraction and force blood out of the heart to supply oxygen to different parts of body. These muscles never tire and when they stop working, the individual dies of cardiac/ heart failure.

Although, the muscles perform tapestries of work in human body their origin is much simpler. All types of muscles arise from a particular type of stem cell called "satellite cells". Multiplication and differentiation of mono-nucleate satellite cells leads to formation of myoblasts. Fusion of myoblast cells with each other and with pre-existing myotubes leads to formation of multinucleate myotubes and higher order muscle fibres. Thus, muscle is the only tissue in the body that is formed by fusion of cells in a predetermined and precise manner. A particular numbers of cells fuse to form a particular muscle at a predetermined neuromuscular connection, each with its own individual identity.

The entire process is coordinated and regulated by specific growth factors such as insulin-like growth factor 1 (IGF-1), hepatocyte growth factor and growth hormones such as testosterone and estrogen. IGF-1 stimulates multiplication of satellite cells to produce more satellite



A. Skeletal muscle B. Smooth muscle C. Cardiac muscle

Different types of muscles in human beings

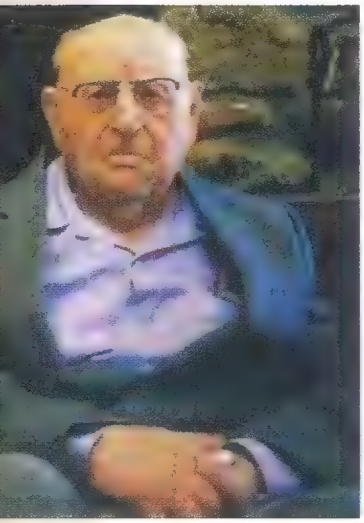
This loss of muscle size and strength that accompanies ageing is known as sarcopenia, which is a significant problem for elderly persons.

cells and further differentiates these cells into myoblasts. In addition to well characterized IGF-1, MAP kinases, RAC/RHO pathway and a novel family of proteins known as Ras GTPase are found to be involved in terminal muscle differentiation.

When working at its optimal best, the muscle system produces the fastest animals like cheetah to the greatest athletes like Jackie Joyner-Kersee, Carl Lewis, Pele, Maradona and Messi. But when there is a problem, the same helpful and powerful muscles shrivel, twist, and degenerate making the individual sedentary. Many times the problem arises due to lack of the protein 'Dystrophin' in muscles or mutations in the genes associated in differentiation of muscles.

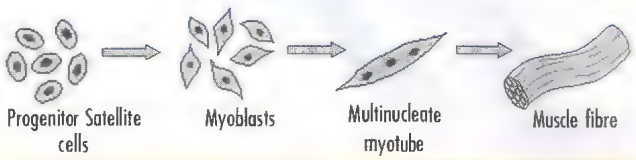
With ageing, production of IGF-1 decreases and muscles shrink, become smaller, weaker and less responsive to the action of IGF-1 so that the impact of exercise on muscle size and strength diminishes. This loss of muscle size and strength that accompanies ageing is known as sarcopenia, which is a significant problem for older persons. While not painful or directly debilitating, sarcopenia is associated with an increased tendency to fall and break bones. Such falls and broken bones are major causes of morbidity among the elderly persons.

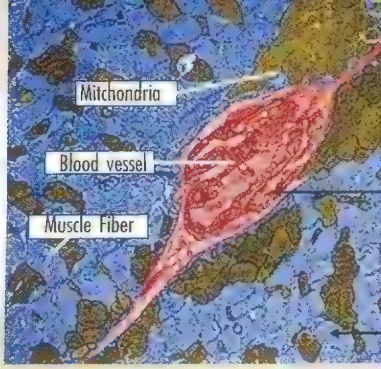
Another chronic muscular disorder with excruciating pain that affects younger people is muscular dystrophy (MD) in which all types of muscles are affected. It is a group of muscle diseases that weaken the musculoskeletal system with progressive muscle weakness, deficient in muscle protein dystrophin, and is inherited through generations. It may occur in childhood or adulthood but more severe forms tend to occur in early childhood.



Most of the victims of the severe form of dystrophies, known as Duchenne's Muscular Dystrophy, die from heart failure. Those who have a milder form, known as Becker's Muscular Dystrophy, can survive to middle age. It is possible that they have a defective gene that makes muscles but the muscles slowly degenerate. In humans the gene responsible for muscular dystrophy disease has been located on the X chromosome and therefore almost always affects males while females act as carriers as they have two X chromosomes and can compensate if one is defective.

Process of muscle formation in humans from progenitor satellite cells to muscle fibres





Dramatically enhanced muscle tissue in a high performing mouse with abundant mitochondria (brown), blood vessel (red cross section) and muscle fibres (blue) *Right.*

The commercial and competitive pressures to use genetic muscle treatments to build up, maintain and repair muscles of diseased, old aged as well as professional athletes has been very strong. Thus, there have been efforts to ameliorate the muscle problem by gene therapy using appropriately regulated efficient delivery of human mIGF-1 to muscle cells. However, this approach, instead, led to pathological enlargement of the heart muscle and thus a cure for the disease remained elusive for a long time.

Recently, growing understanding of muscle physiology at the molecular level coupled with sophisticated genetic engineering has made it possible to enlarge skeletal muscles selectively, without damaging heart muscles in the process. An international team of scientists has created super-strong, high-endurance muscles by tweaking a gene called *NCoR1*. This creates a new avenue for treating muscle degeneration in people who are unable to exercise due to obesity or other health complications, such as diabetes, immobility and frailty or injured young athletes.

Contrary to known dogma, scientists found that NCoR1, a natural muscle-growth inhibitor, is responsible for determining the strength of our muscles. NCoR1 are molecular brakes that decrease the activity of genes. Releasing the brake by mutation or with chemicals reactivates gene circuits to provide more energy to the muscle and enhances its activity. By modulating the activity of this gene they were able to create a mighty mouse whose muscles are twice as strong as those of normal mice. The muscles of engineered mouse have more blood vessel, muscle fibres and more numbers of mitochondria to provide more energy to the muscles. The mice with the mutation became true marathoners, capable of running faster and longer before showing any signs of fatigue. They were able to cover almost twice the distance run by mice that had not received the treatment and exhibited better cold tolerance.

Unlike previous experiments that focused on genetic accelerators such as IGF1, this discovery shows that suppressing an inhibitor is a new way to build muscle. Examination under a microscope confirmed that the muscle fibres of the modified mice are denser and massive. Interestingly, no harmful side effects were detected by elimination of NCoR1 from muscle and fat tissues. While the IGF1 approach had advantages and disadvantages, the mouse experiment suggests treatments for age-related or genetics-related muscle degeneration are within reach. However, developing any one of them would take some time and drug administration would require demonstrations that the proposed treatment is safe, effective and free of undesirable side effects.

Current finding gives us a glimpse of possible long-term therapeutic applications for humans. If the results are confirmed in humans, the new approach will prevent or delay such loss of muscle strength and thereby decrease the frequency of broken bones in the elderly or muscular dystrophy in young people.

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Prize Puzzle

THE PHILATELIST

A girl has six red stamps and three blue ones. In her collection, seven stamps are from India and six stamps are from France. One stamp is purple and it is not from India or France. Two of her Indian stamps are red and one is blue. Two of her French stamps are blue and three are red. How many stamps does she have?

ANSWER

There are three prizes of Rs. 500/– each for three correct entries. In case there are a large number of correct entries, the prize winner will be selected through a draw of lots. The decision of the Editor, *Science Reporter*, will be final.

Last date for the entries to reach us: 05-03-2012

Puzzle Corner
Science Reporter
National Institute of Science Communication And
Information Resources, CSIR, Dr. K.S. Krishnan Marg
New Delhi-110012

Your Name : .....

Address : .....

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.....Pin Code : .....

Age : .....E-mail :..... .....Sex : .....

Occupation : ☐ Student ☐ Housewife ☐ Teacher ☐ Professional ☐ Retired ☐ Other

Educational Level: ☐ Primary ☐ Secondary ☐ Graduate ☐ Postgraduate

*Please fill up the questionnaire at the back

*Please note: Now you can even send your answers on a photocopy of this page.

ALPHA-NUMERIC SUDOKU

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		6	0	4			C			7			2	8	
			2		A						B	0	7		6
			F	6	1		3	0	E	8		5			
		A	C			D		2	5					B	4

Contributed by Mr Vijaya Khandurie, Address: A-2/603, Glaxo Apartments, Mayur Vihar Phase-1 Extension, Delhi- 110 091

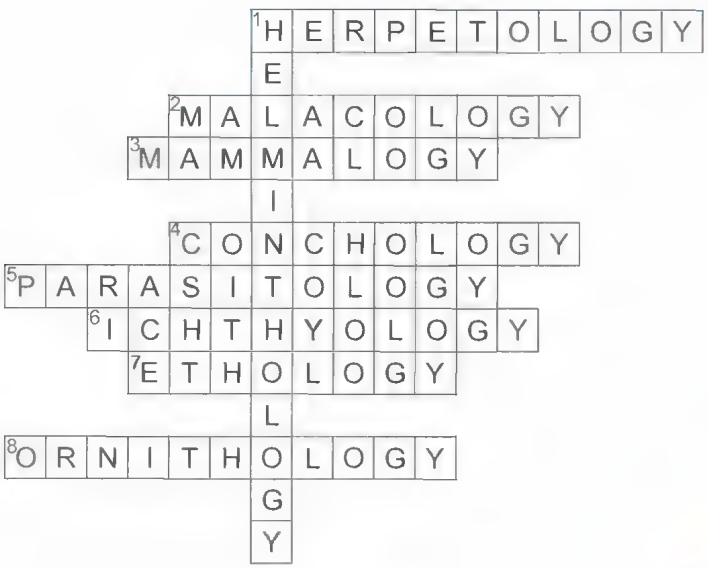
MATCH THE DISEASE

Plant diseases	Animal diseases
Citrus canker *Xanthomonas citri*	Botulism *Clostridium botulinum*
Late blight of potato *Phytophthora infestens*	Anthrax *Bacillus anthracis*
Crown gall disease *Agrobacterium tumefaciens*	Diphtheria *Corynebacterium diptheriae*
Common scab of potato *Streptomyces scabies*	Malaria *Plasmodium spp.*
Damping off *Pythium debarynum*	Tuberculosis *Mycobacterium tuberculosis*
Papaya mosaic *Papaya ring spot virus*	Brain fever Influenza virus
Tomato leaf curl *Tomato leaf curl virus*	Influenza *Hymophilus influenza*
Wart disease of potato *Synchytrium spp.*	Peptic ulcer *Helicobacter pylori*
Leaf blight disease of rice *Xanthomonas oryzae*	Infantile diarrhea *Rotavirus*
Red rot of sugarcane *Colletotrichum falcatum*	Avian influenza H5N1

SOLUTIONS TO PUZZLES PUBLISHED IN THE DECEMBER 2011 ISSUE

PRIZE PUZZLE:

LOGY QUIZ



THE NAMES OF THE PRIZEWINNERS ARE AS FOLLOWS:

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CONGRATULATIONS ALL THE WINNERS!

SAKSHI CHANA, RAJAT MATHUR & MAN MOHAN SINGH

Photographs by Mr. Mohd. Shaheer Warsi

Metals in Your Denture How Safe?

Metals find a prominent place in dental practice. Which are these metals and how safe are they?

HISTORICALLY, the most common material used to replace missing teeth and to fill decaying teeth has been gold and its alloys. But with ever increasing gold prices, dental experts started looking for possible substitutes. Initially, these too were metallic. Later with cosmetic dentistry coming into the limelight, search for newer materials to fill and replace missing teeth with tooth-colored substitutes was initiated. This is when the concept of 'metal-free practice' originated.

However, despite recent advances, metal-free dental practice appears practically unfeasible, since the dentist who truly maintains a practice free from use of all metals and metal alloys, would deny patients some of the best restorative materials known to dentistry today.

Metals and Metallic Alloys in Dentistry

Etruscans (or civilization of ancient Italy sometime in the 7th century) are believed to have been the first to use gold in dentistry. During those days, tooth of an animal such as a cow or a calf properly fastened with gold wiring was used to replace a lost tooth. Later, metals were used in the fabrication of crowns, bridges and dentures. High purity (99.7%) gold was perhaps the oldest metal used in this field. Today, however, a wide range of metallic alloys find application in almost all processes of dentistry. These include (a) precious metallic alloys such as gold-platinum alloy, gold-palladium alloy, gold-copper-silver alloy, (b) semi-precious metallic alloys such as silver-palladium alloy, palladium-copper alloy, silver-gold-copper alloy, (c) base metallic alloys such as cobalt-chromium alloy, nickel-chromium alloy, and (d) titanium based alloys such as nickel-titanium alloy.

Pertinently, minor composition changes in base metal alloys are known to cause significant beneficial effect in their ease of casting, bonding, hardness and strength. This takes care of the sag of alloys at elevated temperatures (also known as the high temperature creep) that can markedly affect fit of the castings. For example, nickel-chromium alloys possess lower sag values than gold alloys.

Dental Crowns

A dental crown is a dental restoration that completely encloses or caps a tooth or a dental implant. Crowns are generally required to improve strength and appearance of a tooth that is so badly damaged that its repair or restoration with conventional filling materials becomes practically impossible. Crowns have been made from a variety of materials such as:

All-/Full-metal crowns

Full-metal crowns (Fig. 1A) are mostly cast from jewelry grade (~18 carat) gold, but may also be cast from certain alloys including high-noble or jewelry-gold (made from gold mixed with platinum or palladium), noble (made from gold, palladium and silver) or base metal (made mostly from nickel and beryllium) alloys.

All-metal crowns are stable and nearly indestructible, since they have no porcelain veneer that could chip or break. They also require less tooth reduction and their bevel makes them more stable and less likely to leak

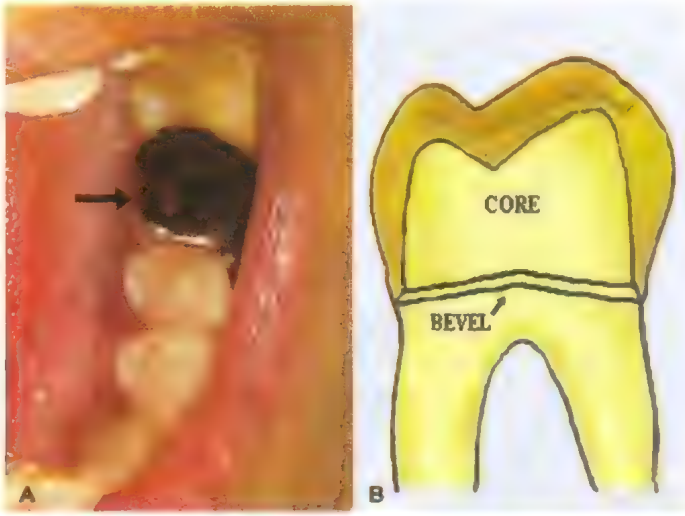
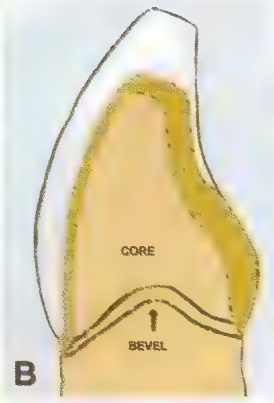


Figure 1.
A: Full-/all-metal dental crown *in situ* (arrow),

B: diagrammatic representation of a full-/all-metal crown vis-à-vis the underlying tooth core



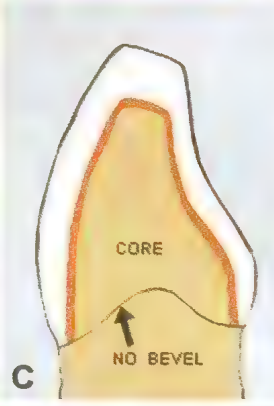
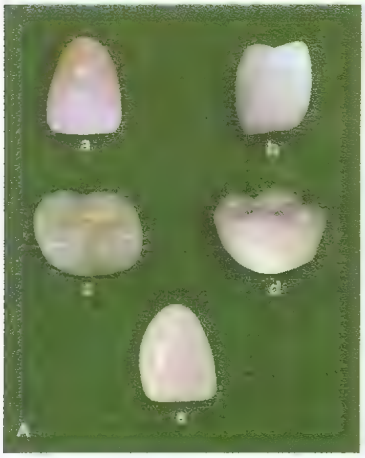


Figure 2.
A: Porcelain-fused-to-metal crowns and diagrammatic representation of a porcelain-fused-to-metal (B) and a porcelain-fused-to-zirconia (C) crown vis-à-vis the underlying tooth core

All-metal crowns are stable and nearly indestructible, since they have no porcelain veneer that could chip or break. They also require less tooth reduction and their bevel makes them more stable .



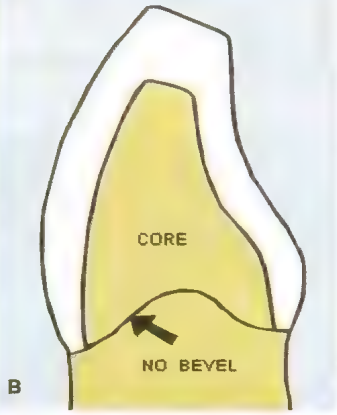


Figure 3. A: Some common non-metal dental crowns, a: porcelain, b: alumina, c: ceramic, d: zirconia, e: polycarbonate, B: diagrammatic representation of a porcelain alone crown vis-à-vis the underlying tooth core (for further details see: http://www.doctorspiller.com/crowns.htm)

Prefabricated crowns are simple, thin, tooth-shaped shells commercially available in a variety of materials and graduated sizes as metal-free alternatives.

The only major disadvantage of this type of crown is its poor aesthetic value. It is because of this reason that they are almost exclusively used on rear chewing teeth.

All-metal crowns are stable and nearly indestructible, since they have no porcelain veneer that could chip or break. They also require less tooth reduction and their bevel makes them more stable and less likely to leak (Fig. 1B). Currently, custom-made single or multiple gold, silver and platinum caps with special engravings, cuts and inset stones are internationally available for cosmetic use.

Porcelain-fused-to-metal (PFM) crowns

Porcelain that is reinforced with metal coping (Fig. 2A) is stronger and usually shows a tiny strip of metal at the gum line, which is generally hidden under the gum line so that appearance of the finished tooth is not adversely affected. This type of crown is generally used on back chewing teeth, and on front teeth in the case of people who habitually grind and clench (brux). Crowns with metal copings are less likely to snap off even when the tooth suffers a mechanical trauma (Fig. 2B). The newest types of PMF crowns use reflective properties of gold to enhance their translucency.

Porcelain-fused-to-Zirconia crowns

Zirconia (or zirconium oxide) is a high performance material, which has been successfully used since the seventies for making artificial limbs and joints. Zirconia ceramic is nearly as strong as metal coping used in PMF crowns, but without metal underneath the porcelain. Strength of the coping makes this type of restoration suit both anterior as well as posterior teeth and have almost the same excellent aesthetics as all-porcelain crowns. It has the added advantage of being fabricated to match the shade of the ideal tooth core. Besides, they are hypoallergenic, biocompatible, radio-opaque and have low thermal conductivity (Fig. 2C).

Prefabricated crowns as metal-free alternatives

Prefabricated crowns are simple, thin, tooth-shaped shells commercially available in a variety of materials and graduated sizes as metal-free alternatives. These include porcelain, alumina, ceramic, zirconia and polycarbonate crowns (Fig. 3A,B). However, due to imperfect fitting, such prefabricated crowns if worn for long durations may cause gum problems at the margins where the crown meets the tooth. Moreover, the contact that such crowns make with adjacent teeth may be poor allowing for food impaction between the teeth.

These crowns also make excessive contact with the opposing teeth causing difficulties in biting. Adjustments to correct excessive vertical height may weaken the finished prefabricated crown. Their life expectancy depends upon how much the dentist has to modify them from their original state to make them fit and how careful the patient is with them. Generally, prefabricated crown is considered a practical temporary alternative to an extraction.

Fixed Partial Denture (FPD) or Bridge

A fixed partial denture or a bridge is a restoration that is used to replace a missing tooth by permanently joining adjacent teeth or dental implants (Fig. 4A). The materials used for making bridges include gold, metal alloys, porcelain-fused-to-metal, porcelain-fused-to-Zirconia or porcelain or ceramic alone (Fig. 4B-D). The extent and type of reduction

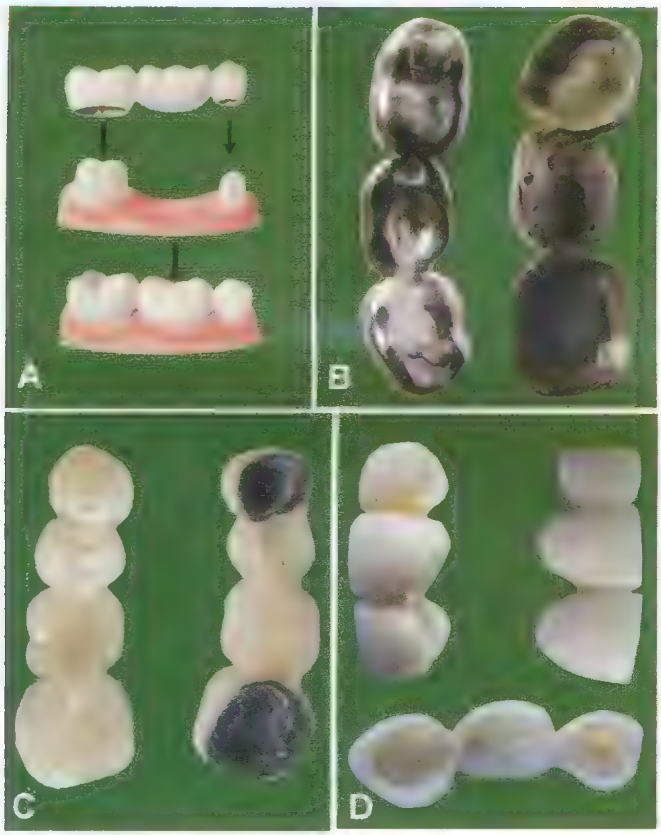


Figure 4. A: Diagrammatic representation of a dental bridge and its fixation. Bridges made from metal alloy (B), porcelain-fused-to-metal (C) and porcelain alone (D)

The materials used for making bridges include gold, metal alloys, porcelain-fused-to-metal, porcelain-fused-to-Zirconia or porcelain or ceramic alone

RPD can be easily modified including adding new teeth.

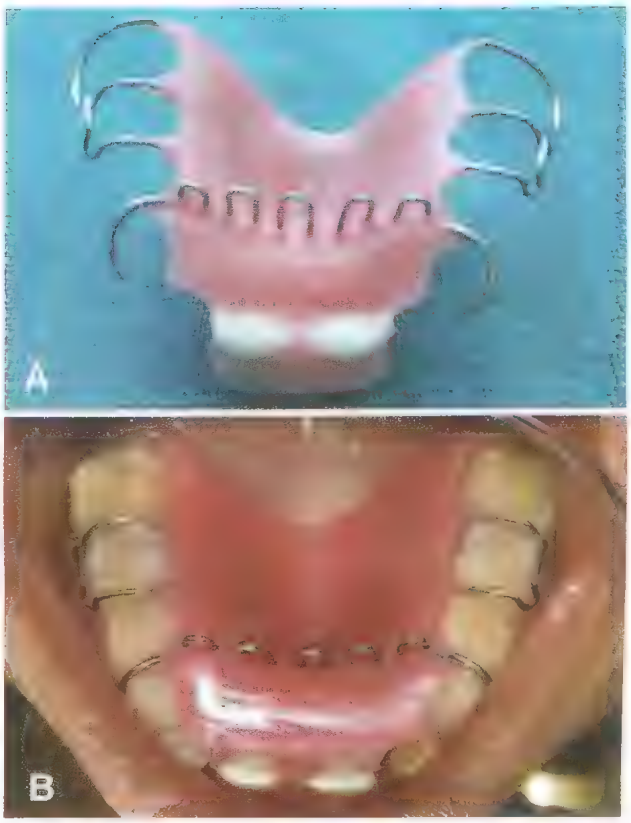


Figure 5. A: Partial denture, B: The same *in* situ. Pink plastic of the denture base is brittle acrylic. It is also used to make standard full dentures

done to the adjoining teeth varies according to the material used.

Removable Partial Dentures

Removable partial dentures (RPD) having cast metal frameworks were initially made from wrought (hammered) silver (Fig. 5A-B). The metal framework did not come in direct contact with the gums. Thus, as the gums resorbed with ageing, these partial dentures did not sink with them and rarely required adjustments. Modern frameworks are made from chrome-cobalt alloy, which is extremely strong and can be cast very thin. In addition, these are lighter, corrosion resistant, are much less perceptible to the tongue, and do not affect taste during eating because of minimal metal framework coverage over transpalatal area. Sore spots are almost never an issue since neither framework nor plastic extensions contact soft oral tissues with any force. They can be easily modified in future including adding new teeth and clasps.

Dental Implants

Dental implants are anchors surgically embedded in the jaw bone (Fig. 6A-C) They are usually made from titanium or titanium alloys and are meant to support dental restorations (such as a crown or a bridge) that are used to replace missing teeth. Implant placement is a minimally invasive technique administered under local anesthesia. Successful replacement of implants is also conveniently achievable.

Long-term studies observing implant solutions for over 15 years confirm their high safety and success rate of >96%. Failure of implants is due primarily to inadvertent loading or risk factors such as poor bone quality and smoking and/or surgical factors. Zirconia implants have also been used in Europe for past many years. They are believed to be highly bio-compatible. Besides, being ceramic, they do not corrode.

Dental or Orthodontic Braces

Dental braces are used to align and straighten teeth, position them with regard to the person's bite and improve overall dental health (Fig. 7A-D). They consist of a small bracket that is glued to the front of each tooth and the molars are adjusted with a band that encircles the tooth. They are often used to correct malocclusions, under-bites, over-bites, cross-bites, open-bites, deep-bites and crooked teeth. In conjunction with other orthodontic appliances, braces have also been used to widen the palate or the jaws.

Modern orthodontists offer many varieties of braces. These include:

(a) *Traditional metal-wired braces* made from stainless steel and/or titanium. These may be conventional braces that require ties to hold the archwire in place or the newer self-tying brackets that reduce friction between the wire and the slot of the bracket and may also provide therapeutic benefit. Titanium braces are lighter and are recommended for persons with allergies to nickel (a basic and important component of stainless steel),

(b) *Gold-plated stainless steel braces* are also employed for patients allergic to nickel in steel,

(c) *Clear braces* that serve as cosmetic alternative to traditional metal braces by blending in more with the natural colour of the teeth or having less conspicuous or hidden appearance. Typically, these are made of ceramic or plastic, but due to higher component of friction, these tend to be more brittle than metal braces and can make their removing difficult and time consuming at the end of treatment and

(d) *Lingual or Incognito braces* are custom made fixed braces bonded to backside of the teeth making them invisible to people and serve as cosmetic alternative to all other types of braces.

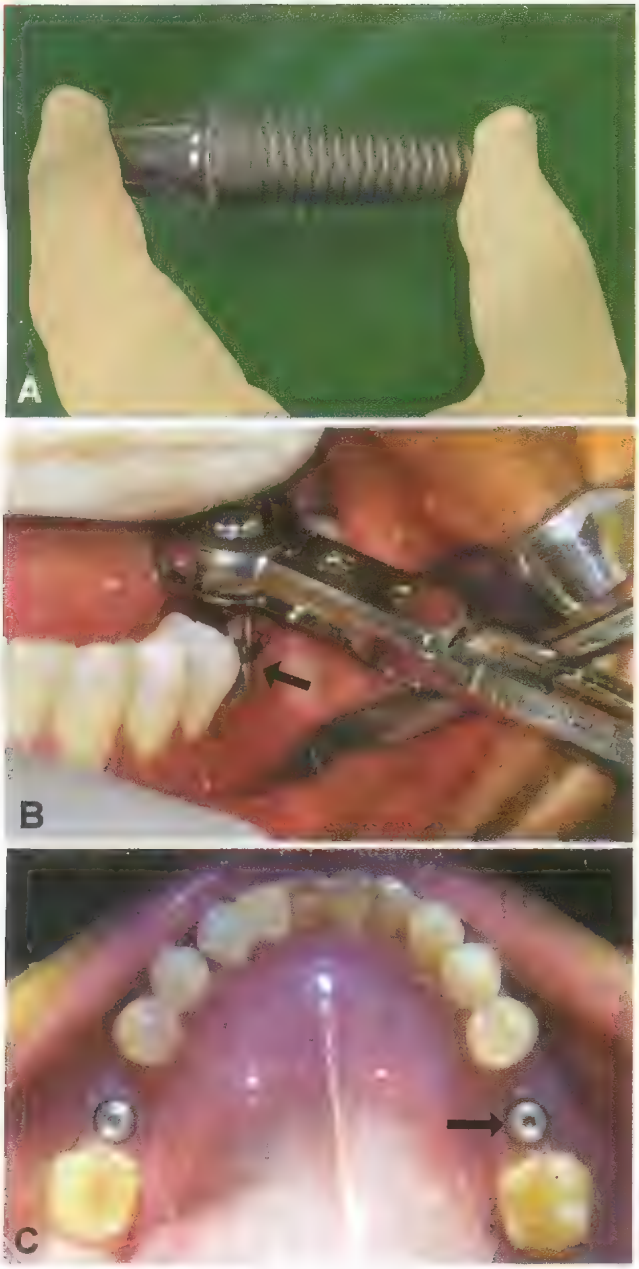


Figure 6. Dental implant (A) and its fixation *in situ* (B, C) (left)

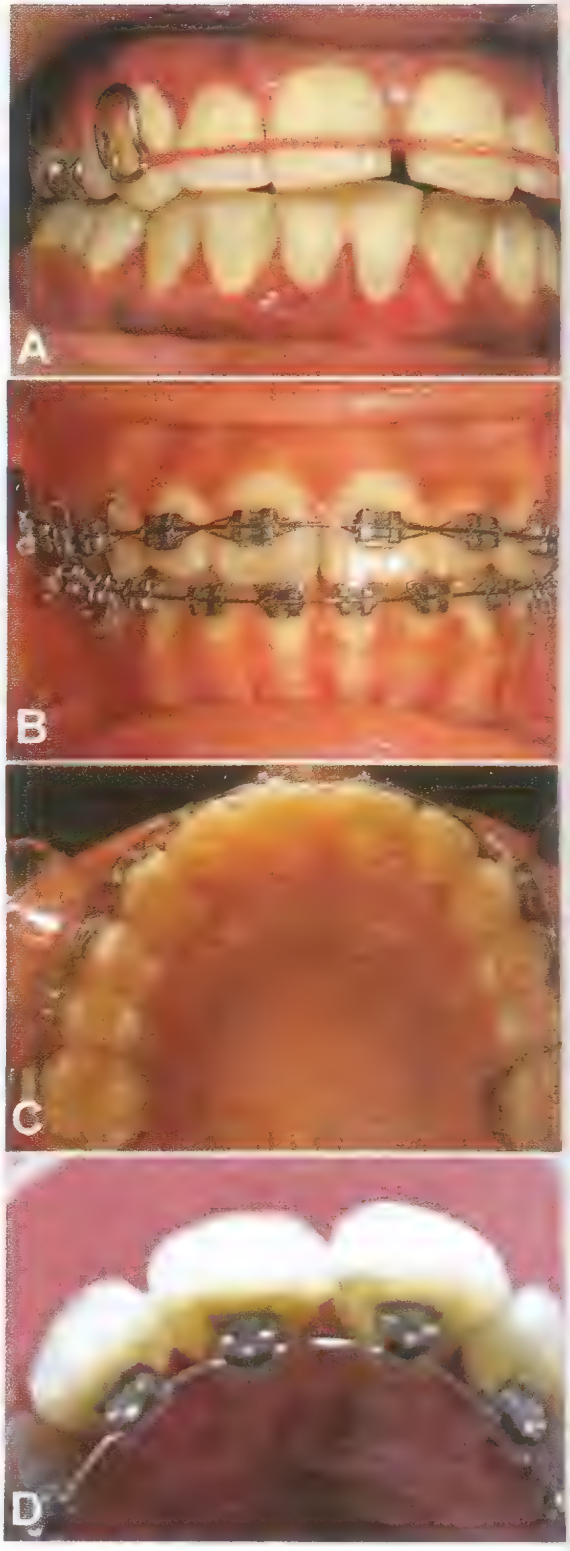


Figure 7. Partial (A) and complete traditional (B, C) and lingual (or Incognito; D) metal-wired dental braces (right)

Long-term studies observing implant solutions for over 15 years confirm their high safety and success rate of >96%.

Dental braces are used to align and straighten teeth, position them with regard to the person's bite and improve overall dental health

The major advantage of braces is that one can continue to eat and drink while wearing brace. But they have to be periodically tightened by the orthodontist causing increasing amounts of discomfort. Besides, one must give up certain foods and habits such as chewing gum while wearing them.

Zirconia implants are believed to be highly bio-compatible. Besides, being ceramic, they do not corrode.

Dental filling or Dental restoration

Dental filling or dental restoration is the material used to restore morphology and functional integrity of the missing tooth structure due to caries or external trauma. Metals mostly used for making crowns, bridges and dentures have been used for dental filling. Efforts have been made to develop new safe and effective dental materials. But current alternatives such as composite resins have not been as effective as dental amalgam in providing durable restorations especially in case of larger fillings.

Gold dental filling: It was as early as 15th century that the first dental textbook published in Leipzig, Germany had recommended use of gold leaf for dental filling. Like the solid gold teeth and gold crown, gold fillings (Fig. 8A) have shown remarkable strength against opposing teeth while being in continuous use.

Amalgam dental filling: Amalgam filling, commonly known as silver or mercury filling (Fig. 8B), is an excellent and versatile restorative material in extensive use for over 150 years in dental health care. It is a mixture of almost equal parts of elemental liquid mercury (43-54%) and an alloy powder (57-46%) composed of silver, tin, copper and sometimes smaller amounts of zinc, palladium or indium. It is inexpensive, relatively easy to use and manipulate since it remains soft for a short interval and can be conveniently packed to fill any irregular volume in a single appointment. Used primarily to fill posterior

Composite resins have not been as effective as dental amalgam in providing durable restorations especially in case of larger fillings.

teeth, it possesses greater longevity when compared to other direct restorative materials, such as composite.

Safety of Metals and Metallic Alloys

Gold is a durable hard metal with unusual strength that expands and contracts at the same rate as natural teeth. The many advantages of gold include its harmless, chemically static nature as it does not get oxidized at any temperature in air or water and there is no effect of hot and strong acids. It has also been proved that gold works really well in oral environment. It is kind to soft tissues, and most importantly it does not react with food acids. Higher gold content dental restorations can stay perfectly well for over 50 years. Thus gold continues to be the champion and no other metal can boast of better restorative properties.

According to reports, the least amount of nickel and chromium is released from arch wires composed of an alloy containing 54% nickel and 46% titanium in corrosion tests. Titanium is highly corrosion resistant and alloying with nickel results in a corrosion resistant alloy. The localized potentiodynamic corrosion resistance of nickel-titanium alloy in artificial saliva and saline has been shown to be slightly lower than that for stainless steel. In corrosion tests using 1% sodium chloride (slightly higher than that of saliva), it has also been shown that nickel component of the alloys may have a selectively higher dissolution rate from the corrosion pit.

It is believed that people are exposed to more total mercury from food, water and air in comparison to the diminutive amount of mercury vapour generated from amalgam fillings. Till date there is no scientific evidence to support that exposure to mercury from amalgam restorations poses any serious health risk in humans, except for few allergic reactions.

According to US Public Health Service report of 1993, in 150 years of continuous use, there have only been about 100 documented cases of allergic reactions to the components of amalgam in dental literature. According to the American Dental Association, given their solid track record, amalgam fillings are still the best bet. The Report of FDA's Dental Products Panel of 1991, too, states that there was no convincing reason to believe that avoiding amalgams or having them removed will have beneficial effect on health. In fact, it is not advisable to have amalgam removed unnecessarily, as this might cause structural damage to the otherwise healthy teeth. Claims that removal of amalgam leads to recovery from multiple sclerosis or that use of amalgam leads to arthritis or Alzheimer's disease remain unsubstantiated.

Pertinently, the dentists, too, are now much less exposed to mercury due primarily to their increased awareness and adherence to precautions as they create and apply dental amalgam. This is based on the observed decreasing levels of mercury concentration during urinary screening in about 1,700 dentists.

Shawn Watson (website: dentistry.guide@about.com), however, believes that there is still insufficient information available regarding effectiveness and safety of dental amalgam, particularly with regard to bioaccumulative effect of mercury and exposure of pediatric populations to mercury vapour. Concerns have also been raised with the US-FDA to consider reclassifying dental amalgam (currently a class II medical) as a class III medical device (that pose greatest risk to patients) based on risk assessment and clinical data that demonstrates dental amalgam as a dangerous filling material.

Another major concern is the presence of bisphenol A in some types of dental fillings and dental sealants. BPA, first synthesised in 1891, has been in use in combination with other chemicals to manufacture epoxy resins used to coat water pipes and polycarbonate plastics employed in many food and drink packaging and even baby bottles. Ever since BPA was found to cause pathological problems ranging from carcinogenic activity to changes in reproductive organs due to its estrogenic property, there has been a world-wide campaign to switch from BPA-containing plastic containers to stainless steel and other BPA-free products.

In view of reports of BPA acting as an endocrine disruptor (i.e., an exogenous substances that alters function of endocrine system and consequently causes adverse health effects in an intact organism, its progeny or subpopulations), US-FDA has recently raised concerns regarding BPA exposure of fetuses, infants and young children. In September 2010, Canada became the first country to declare BPA as a toxic substance. European Union and Canada have banned use of BPA in baby bottles.

Figure 8. Dental fillings, A: Gold, B: Amalgam

According to the American Dental Association, however, level of BPA in dental materials is insignificant. The American Dental Association's Council for Scientific Affairs released a statement in July 2010 that BPA is rarely used as a formula ingredient in dental products, and according to research, exposure to BPA via six dental sealants for a male child aged 7-14 years is 2-5 times lower than the estimated daily exposure from food and environmental sources.

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QUIZ ON DINOSAURS

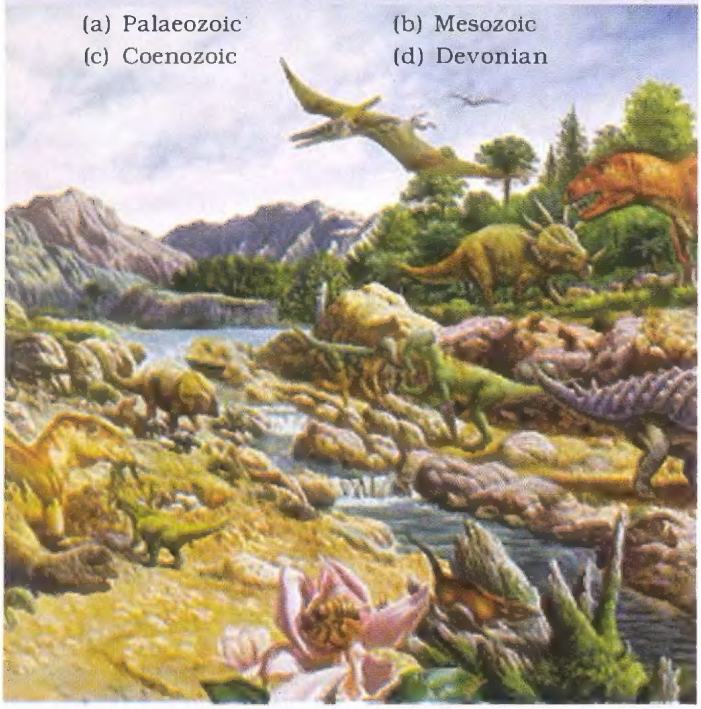
PRAFULLA KUMAR MOHANTY

1. Which of the following is the meaning of the word 'dinosaur'?
(a) Horrible reptile (b) Terrible reptile
(c) Terrible lizard (d) Miserable reptile

2. Which of the following is the synonym of the word 'dinosaur'?
(a) Deinosaur (b) Dainosaur
(c) *Dinotherium* (d) *Dinoceras*

3. Who first named the term dinosaur and when?
(a) GK Noble 1933
(b) Sir Richard Owen 1841
(c) HH Newmann 1843
(d) JZ Young 1884

4. During which geological time did dinosaurs flourish on earth?
(a) Palaeozoic (b) Mesozoic
(c) Coenozoic (d) Devonian



5. What category of animals are dinosaurs?
(a) Reptiles
(b) Reptiles and birds
(c) Amphibians and reptiles
(d) Reptiles and mammals

6. Which of the following animals evolved before dinosaurs?
(a) Fishes (b) Fishes and amphibians
(c) Amphibians (d) Fishes, amphibians and lizards

7. Which of the following is the huge extinct proboscidean with elephant-like tusks and trunk?
(a) *Dinoceras* (b) *Dinornis*
(c) *Dinotherium* (d) *Triceratops*

8. Which of the following dinosaurs were found in India?
(a) *Brontosaurus*, *Stegosaurus* and *Ankylosaurus*
(b) *Apatosaurus*, *Allosaurus* and *Mosasaurus*
(c) *Herrasaurus*, *Brachiosaurus* and *Diplodocus*
(d) *Titanosaurus*, *Dravidosaurus* and *Rajasaurus*

9. Which of the following dinosaurs is named from Seymour, Texas where it was first discovered?
(a) *Brontosaurus*
(b) *Stegosaurus*
(c) *Seymouria*
(d) *Pterosaurus*

10. Which of the following is the morphological characteristic of dinosaurs?
(a) Naked skin (b) Slimy body
(c) Soft scales (d) Hard scales

11. Which of the following dinosaurs had a sail like structure on their back?

(a) *Dimetrodon*
(b) *Seymouria*
(c) *Ankylosaurus*
(d) *Iguanodon*

12. Which of the following is believed to be the oldest reptile on earth?

(a) *Hylonomus* (b) *Dinotherium*
(c) *Ichthyosaurus* (d) *Pterosaurus*

13. Which of the following dinosaurs is known as the fish-lizard?

(a) *Pelycosaurs* (b) *Ichthyosaurus*
(c) *Pteranodon* (d) *Ankylosaurus*

14. Which of the following dinosaurs is popular as the flying dinosaur?

(a) *Pterosaurus*
(b) *Tyrannosaurus*
(c) *Triceratops*
(d) *Iguanodon*

15. Which of the following dinosaurs was first described scientifically in 1824?

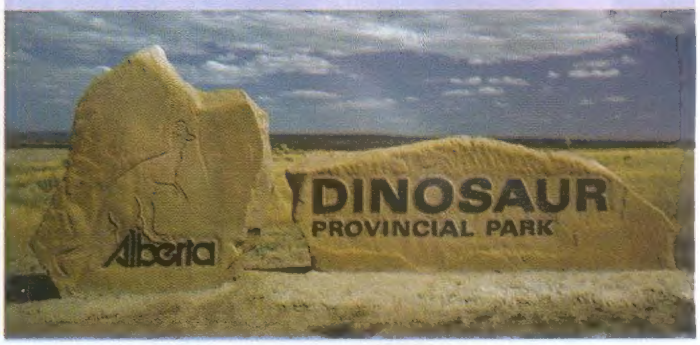
(a) *Brontosaurus* (b) *Ankylosaurus*
(c) *Pteranodon* (d) *Megalosaurus*

16. Which movie was based on dinosaurs?

(a) Triassic Park (b) Jurassic Park
(c) Cretaceous Park (d) Dinosaur Park

17. In which part of the world can a real "Dinosaur Park" be observed?

(a) Red Deer River, Alberta
(b) Antarctica
(c) China
(d) Flaming Cliffs, Gobi Desert, Mongolia



18. Which of the following dinosaurs is considered as the largest carnivorous dinosaur and named as the "king of dinosaurs"?

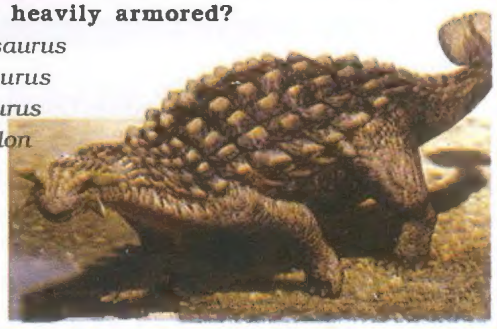
(a) *Apatosaurus* (b) *Camptosaurus*
(c) *Stegosaurus* (d) *Tyrannosaurus*

19. Which of the following dinosaurs had characteristic plate-like structure on the dorsal side of the body?

(a) *Ankylosaurus* (b) *Brontosaurus*
(c) *Iguanodon* (d) *Stegosaurus*

20. Which of the following dinosaurs is known as the "tank of the Mesozoic battle field" as they were heavily armored?

(a) *Ankylosaurus*
(b) *Stegosaurus*
(c) *Mosasaurus*
(d) *Iguanodon*

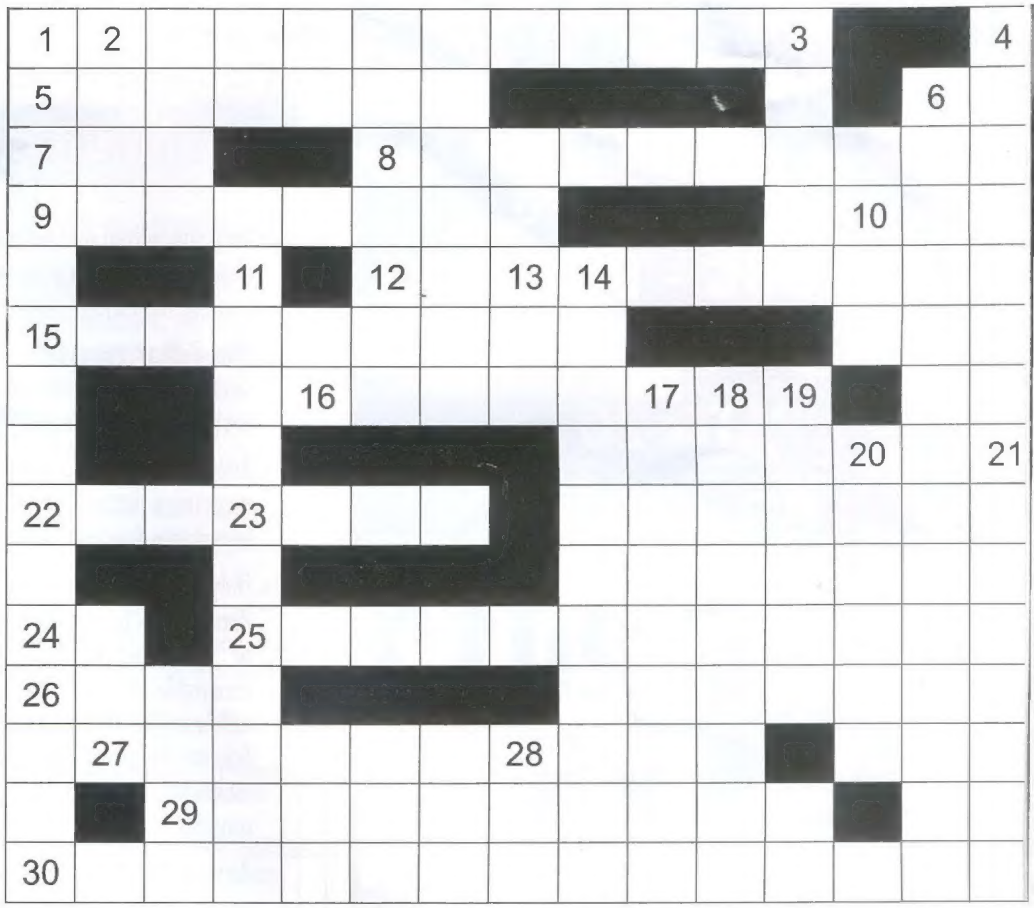


ANSWERS:

1. (c)	2. (a)	3. (b)	4. (b)	5. (a)	6. (b)
7. (c)	8. (d)	9. (c)	10. (d)	11. (a).	12. (a)
13. (b)	14. (a)	15. (d)	16. (b)	17. (a)	18. (d)
19. (d)	20. (a)				

Contributed by Dr. Prafulla Kumar Mohanty, Professor and Head, Post Graduate Department of Zoology, Utkal University, Vani Vihar, Bhubaneswar-751 004; Email: prafulla.mohanty3@gmail.com

CROSS WORD



ACROSS

2. Forces arising due to the hydrophobic interaction of the non-polar side-chains are named after him. (3,3,4)
5. An Anticoagulant (7)
7. Radioimmunoassay (3)
8. Sedimentation constant is referred to by his name (8)
9. Cancer-causing gene (8)
12. A hallucinating chemical (3)
14. Lactic acid cycle is also known by his name (4)
15. Substance that causes allergy (8)
16. Bond between two electro-negative elements where they share electrons (8)
22. Excretory product of spider (7)
24. Chemical symbol for gold (2)
25. In this part of ruminant stomach, cellulose is digested (5)
26. Pleura pneumonia like organism (4)
27. Genus name of the beetle that is a pest of coconut (7)
29. Migratory bird that covers 17,000 km/year (6,4)
30. Migration of a charged particle under the influence of electric current (15)

DOWN

1. Technique by which amino acids like chemicals are separated using filter paper (14)
2. Blood vessel that carries impure blood (4)
3. Venereal disease research laboratory (4)
4. A suspension of weakened or killed pathogen (7)
6. Apparatus that helps to count blood cells (13)
10. Virus that causes AIDS (3)
11. Stationary phase in ion exchange chromatography (5)
13. Genetic material (3)
14. Most abundant polysaccharide found in plants (9)
17. This term refers to a measure of the degree
18. Electrically neutral particle (7)
19. Primary lymphoid organ (6)
20. These cells secrete androgen (6)
21. Protein deficiency disease (8)
23. Nuclear Magnetic Resonance (3)
28. Single cell protein (3)

Contributed by Dr K. Venkataraman, A-T-2 Porkudam apartments, Bypa Road, Madurai-10

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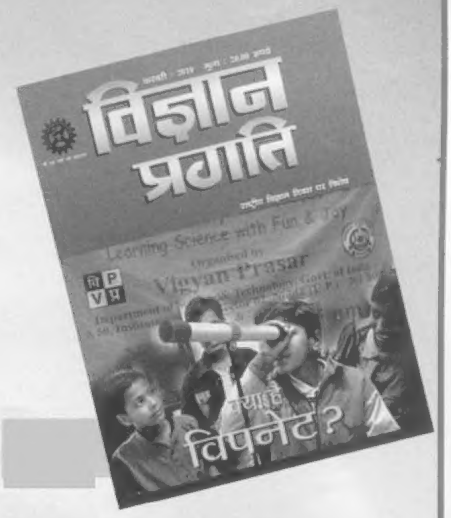

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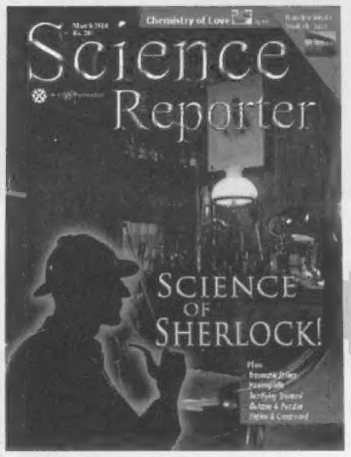

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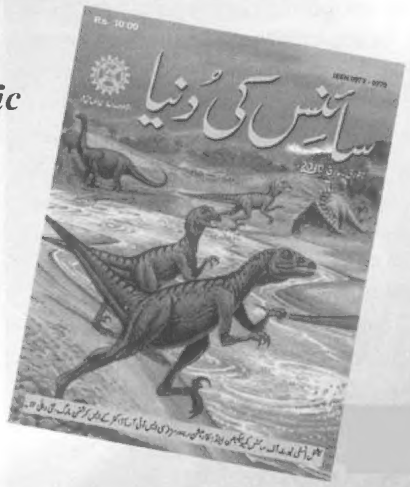

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